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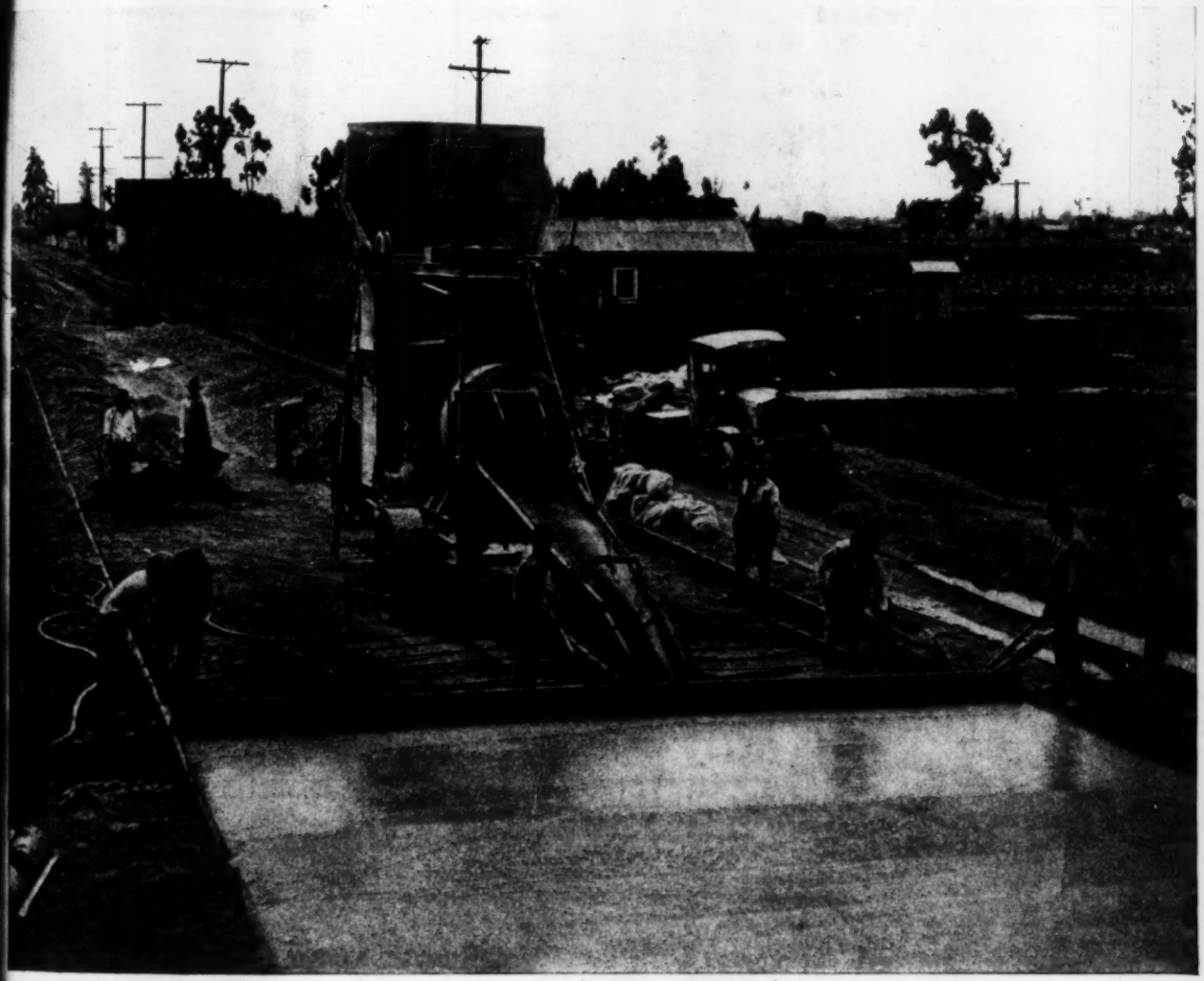


Special Concrete Highway Built for Motor Trucks

Laying Special Concrete Motor Road between Los Angeles and the Pacific
(Cover Illustration)

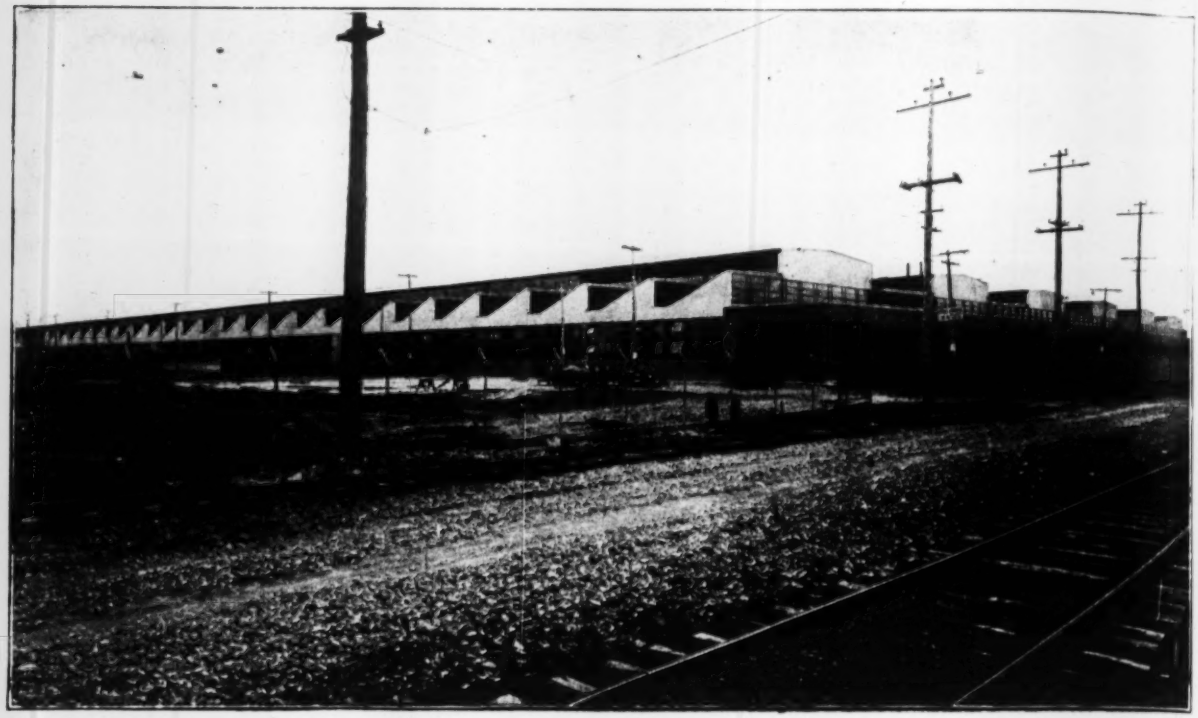
Nine Years' Operation of the Baltimore Sewage Works

By Theodore C. Schaetzle

Railway Bridge Construction and Service by American and European Standards

By P. H. Chen

Joint Committee's Tentative Concrete Specifications



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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. MEHREN *Editor*

Volume 87 — NEW YORK, JULY 14, 1921 — Number 2

British Coal Strike

THOUGH the British coal strike was terminated ten days ago, after it had been in progress eighty-eight days, full details of the agreement are not yet available. This much is certain, however, that the settlement has been underwritten by the British taxpayers to the tune of £10,000,000. Also, some sort of profit-sharing scheme has been agreed upon, conditional, of course, on there being profit, but whether this profit sharing is through national or through district pools is not clear. The full details should make interesting reading.

Professor Burr on Education

ATTENTION was called last week to the forceful address delivered by Prof. William H. Burr before the Society for the Promotion of Engineering Education. The address is referred to again because it is printed in this issue and his views are therefore available to the members of the profession. There are not many subjects that would yield more value to the profession than a serious consideration and discussion of Professor Burr's paper. How many engineers feel that a college course is a *desirable* prerequisite to engineering study? How many would go further and hold that a college course should be made a *compulsory* prerequisite to engineering study? The profession needs to know where it stands on this all important subject.

Relief for the Railroads

REFUNDING by the government of the indebtedness to the railroads for capital expenditures under Federal control will not only afford material relief to the railroad industry, but also to business in general. Ordinarily under private operation, such totals for capital expenditure would be provided for by long-time bonds or in a few cases by the issuance of stock. Even in normal times it would be unusual for the carriers to be called upon immediately to pay cash for a $500,000,000 improvement program. In the present serious situation of the railroads it would be practically impossible. Refunding the government debt should go far toward relieving the railways.

Heroic Flood Protection Work

EMERGENCY levee construction demanding heroic measures for the safety of hundreds of people and millions of property value was a spectacular feature of the recent accomplishment by engineers at Trotter's Front, described elsewhere in this issue. The work was noteworthy not only as record breaking construction, but also as an example of the cool judgment of engineers during times of great stress. The flood threatened a territory of more than 3,000 square miles with the populations of many prosperous towns and property assessed for over $100,000,000. While observations were being taken and forces for the work organized, the engineers made their plans. Then construction started, gathering momentum as it progressed. The work was a success and a disaster was averted.

Tunnel Work Resumed

THE opening of bids this week for the Jersey ventilating shafts of the Hudson River vehicular tunnel and the fixing of a date early next month for the official ceremony of breaking ground at the west end of the tubes marked a resumption of amicable relations between the New York and New Jersey commissions, which have been at loggerheads for many weeks. The result has been that while the two commissions debated their differences over the proposed widening of Jersey City streets at the joint expense of the two states, a valuable portion of the construction season was slipping by with no work in progress on the Jersey side of the interstate subaqueous route. At this writing the long-drawn-out controversy over the status of the board of consulting engineers, "dismissed" by the Jersey commission, is still in doubt, but the indications are that this will be adjusted at an early date. The important thing is that the deadlock has been broken and that sufficient progress will have been made on the Jersey shafts to advertise for bids by Sept. 1 for the construction of the shield-driven twin tunnels under the river. These constitute, of course, the main contracts. The engineering plans and specifications for the river portion of the tunnel are completed, so that, so far as the technical features of the work are concerned, there is nothing in sight to delay actual tunnel excavation.

Try the Cement Suit

AS ANNOUNCED in our news columns last week the Department of Justice has instituted another civil suit against the cement manufacturers for a violation of the Sherman Act, although the similar action brought in New Jersey in August, 1919, has never come to trial. The bringing of the former action was the occasion of a "grand-stand play," in which the Washington correspondents were given to understand that this was a first move on the part of the then administration "to reduce the cost of living." It did not seem to occur to Washington that the connection between the cost of living and cement was rather remote. In fairness to the manufacturers and users of cement no delay in the new action should be permitted or encouraged by the Attorney General. If the open-price and other methods jointly followed by the manufacturers are illegal, cement users who presumably suffer by such illegal methods are entitled to early relief. If those methods are legal, the much attacked cement makers should be given a clean bill of health. There has been too much talk of trade restraint in the cement business to permit the situation to drag along on general impressions and one-sided accusations.

Baltimore Sewage-Works

LARGEST of American cities to treat its sewage, Baltimore has been remiss in not publishing annual reports giving operating data for its sewage-works. This makes all the more welcome the article begun on p. 50 of this issue summarizing operating experiences and results for the nine full years since the plant was put in operation. The changes in design and operation outlined, together with the monthly and yearly averages of laboratory results and the yearly costs of treatment, make the article unique in the literature of sewage treatment. Of special interest are the comparative data for one-story settling tanks, separate sludge digestion tanks and for two-story or Imhoff tanks, and the account of the alterations made in the latter. Interesting also are the brief summaries of activated-sludge and of grease-recovery tests at Baltimore. Every city owes to itself and other cities well-presented data on the operation of its public works, particularly those having so many and vexing problems as are constantly present in sewage treatment. It is to be hoped that Mr. Schaetzle's excellent summary of nine years experience in operations of the Baltimore sewage-works will stimulate the responsible city authorities to make sure that full annual reports are published hereafter.

Steel Lower

FOR the second time in three months the United States Steel Corporation announces a reduction in prices. The prevailing market had been below the official figures for some time. The announcement thus follows rather than leads the market. The corporation in former years maintained an unquestioned leadership in prices—a leadership which Judge Gary succeeded in holding for many years, and from which much good resulted. The stability of the steel market was never in doubt while that policy prevailed. The readjustment now going on in this country is part of the slow, downward drift of steel prices. What point in that movement has been reached? Probably under existing conditions of low demand, the bottom level will be determined less by production cost than by the confidence of the industrial world in the soundness of the schedule. Whether the present readjustment will establish this confidence and revive purchase and production cannot yet be foretold. It is our judgment that it will not. Prices must go still lower before they will help to stimulate demand. The 1913 average price for shapes, Pittsburgh base, was $1.50; in December, 1914, the minimum of $1.08 was reached. The newly announced price reduction brings the figure to $2.00. The price will, we believe, have to go under that to tempt large buying.

Radio on Construction Work

IN THE last two years the use of radio as a means of communicating with construction camps in remote regions has received much attention in the West. This has been because of the much more effective apparatus developed during the war and the comparatively large number of men now available who have had training in the installation and operation of radio equipment. The cost and time required for constructing telephone lines through rough mountainous territory and the difficulty of maintaining those lines in high altitudes during the winter season are strong arguments for the use of wireless. Power companies adding new generating plants to their systems were naturally the first to apply the idea because their staff included engineers more or less familiar with the principles of radio and because in their case the equipment promised to be permanently useful. After construction was completed it would enable the company to maintain communication with the remote generating stations independently of the telephone lines which are so often subject to derangement, particularly in times of storm when means of communication are likely to be most urgently needed.

In addition to the two radio systems described on p. 57, many Western power companies are using radio in a small way or are considering plans for extensive installations. It is safe to say that very soon this will be the generally accepted means of communication with all mountain stations and camps operated by the power companies.

Manifestly the radio telegraph, requiring specially trained operators (and, if a wave length of over 200 meters is desired, operators holding a commercial grade license) is not as convenient as the radio telephone. The latter has been used successfully but the simplification gained by substituting speech for code signals seems to be lost in the extra skill required to keep the telephone apparatus in a stable working condition. Moreover, the range and dependability of the radio phone, even with the most skilled operator, is less than with the telegraph, so that, on the whole, experience to date suggests the use of the telegraph with means for switching over from telegraph to telephone when conditions become favorable.

The West will naturally lead in the application of wireless communication to construction service because of the particular advantages attending its use there. Present indications are that development will be rapid. Now that the power companies have paved the way, engineering contractors may be expected to follow in adopting wireless on construction work.

John F. Wallace

NO NAMES in American engineering, up to the present at least, are likely to be more enduring than those associated with the construction of the Panama Canal. It is the foremost of our Federal engineering enterprises. It is a project of tremendous importance in world trade. It has important international political bearings. It was the scene of a notable failure in the history of engineering enterprises, a failure turned into brilliant success by American engineers.

Last week the first of the chief engineers on the Panama Canal, John F. Wallace, passed to the beyond. Though constantly engaged on important engineering enterprises since his retirement from the Panama work, his personality was largely merged with that of the corporation of which he was the head. Consequently he has not stood out as strongly among engineers as his previous work and his later achievements warranted. His standing among engineers and his great ability, however, are fully attested by his selection, after painstaking search, as the first chief engineer of the Panama enterprise. He had won his spurs by his achievements in the Middle West, and his engineering associates had honored him in 1900 with the presidency of the American Society of Civil Engineers. That he displayed at Panama the same qualities which had won him such national recognition among his associates is attested by all who are familiar with the Panama job. His was the work of picking up the wreckage of the French

enterprise and bringing some semblance of order and organization out of that chaos. General Goethals himself has generously given credit to his predecessors, Wallace and Stevens, for what they accomplished previous to his advent on the job.

His passing is a fitting time to emphasize the place which his connection with the Panama Canal will give him in the annals of American engineering.

Through Foreign Glasses

GETTING the viewpoint of the man at a distance is usually as valuable as it is refreshing. Customary ways of doing things somehow look different when seen through another's glasses; we are apt to perceive a problem where previously everything looked secure and standardized. Of course the recognition of a problem paves the way to its ultimate solution. It is quite possible, therefore, that the comments of P. H. Chen on bridges and locomotives in China may have a constructive effect.

Since the first step in dealing with a new problem is to examine the correctness of its premises and statements, it will be necessary before much headway can be made in the present case to weigh Mr. Chen's charge that bridges of American design are heavier and more costly than their European counterparts—a charge none the less for the mildly questioning way in which it is put. Sufficient information on this subject should be obtainable at home for at least tentative conclusions, and it is to be hoped that American engineers will take the trouble to record their observations of facts supporting or traversing the Chinese comparison. Certain pieces of evidence to hand at the moment are conflicting, some confirming and others opposing the claim made as to the relative economy of bridges designed by American and by European engineers. But a prime difficulty of the case is that it is not easy to know whether a given comparison is on an even basis—whether it involves the same loading, similar conditions as to clearance and other governing factors, and equal excellence of design.

Passing over for the present what the article says on the subject of bridges, we come to a point that may prove to be of pivotal importance, namely, the behavior of American and European locomotives. An experiment is recorded which shows that an American locomotive sets up lateral vibrations in a bridge several times as violent as those set up by a European locomotive. The test is perhaps too crude to be conclusive, but until disproved by more careful experiments it must be taken as indicating that American locomotives are needlessly rough on the structures that carry them. It would appear that there is a good bit of room for improvement in locomotive construction.

So far as this locomotive effect concerns bridges, it would require stiffer construction. Does this, possibly, account for the fact that we build our bridges of stiffer proportioning, with very much heavier bracing, and with larger allowance of extra metal for "impact" than do European bridge constructors?

Obviously, if we *must*, for certain operating advantages, tolerate great unbalance in the driving wheels and violent nosing effects, then our bridges must be made correspondingly more robust; but the added expense involved here should be justified by the operating gain and by the gain in service value of these rougher locomotives. Is any such gain in fact realized?

What is much more important than the effect of locomotive unbalance on bridges, however, is its effect on track. It seems a fair inference that if a particular locomotive is two or three times as severe in its lateral effect on a bridge as another locomotive, the former will also be more severe on track and roadbed. Track injury and maintenance costs presumably are a function of these lateral effects, and would be reduced by lessening the lateral forces. Since maintenance charges are a weighty element of railroad costs today, their reduction would be eminently worth while, especially as a gain in safety of operation might also be expected to follow such a change. In other words, the question presented is whether the locomotive with unnecessary unbalance and nosing may not have much more to answer for than merely additional cost of bridge construction. If the answer is affirmative, then our standard locomotive construction is indeed challenged; its operating advantages, if any, must be balanced against not merely a bridge charge but, possibly, a considerable part of the entire track maintenance charge of our railways.

Safety in Service

COMMON practice in proportioning the wooden floor joists of bridges or of buildings where the loading is likely to produce shock or severe vibration is to make an additional strength allowance for the impact and vibration effects. This is done either by increasing the computed (static) stresses by a certain percentage (impact increment) or by the substantially equivalent process of proportioning the parts for a heavier loading than will actually be applied; the former method is the customary one for bridges, the latter for warehouses and dancing floors. It is now proposed to do away with such extra strength allowance, on the ground that timber is stronger under the shock of suddenly applied load than under quiescent load. This proposal is made by the Timber committee of the American Society for Testing Materials in its recent report.

After recommending certain values for working stresses for quiescent load the committee makes these values applicable to impact loading by giving formulas which increase the allowable working stress for design in exactly the same ratio that the computed stress is increased by the impact allowance. Thus the committee virtually says that impact may be ignored entirely so far as timber is concerned. Undoubtedly the underlying experimental fact, namely, that steady load has a more severe effect on timber than transitory load, is well established. But heretofore no one had interpreted this fact as wiping the impact factor off the slate entirely. Blows or vibratory influences produce rather complex effects on structures—hardly as simple as those arising from mere transitory loading.

It seems likely that engineers and architects who have heretofore considered it necessary to make impact allowances in timber structures as well as in steel, may be reluctant to change their practice on the recommendation of those who speak only for the quality of material, not for the action of structures and their loads. The problem at issue is one that on the face of it involves both the material and the service, and its proper answer is bound to call for the experience of the representatives of both. In the meantime it may be said that the proposal of the committee is of unusual interest, and distinctly of a kind to invite discussion since it involves the important issue of due safety in service.

Nine Years' Operation of the Baltimore Sewage-Works

Plant Comprises Bar Screens, Venturi Meters, Hydrolytic and Separate Sludge Digestion Tanks, Imhoff Tanks, Sludge Drying Beds, Revolving Screens for Tank Effluents and Sprinkling Filters—Sludge Sold

By Theodore C. Schaetzle
Principal Sanitary Chemist of Sewage-Works, Baltimore, Md.

With the publication of the 1914 report of the Baltimore Sewerage Commission the last consistent record of the development of Baltimore's vast sewerage system ended. Throughout the years that this report was published some mention was made of the sewage-works, always in reference to its construction features—except for the 1911 report, which dealt extensively with the experiments upon the results of which the present system was adopted. Numerous articles on the construction of the plant appeared in the engineering periodicals but little as to its operation, and some erroneous ideas regarding the Imhoff tanks completed in 1916 have been circulated. These facts combined

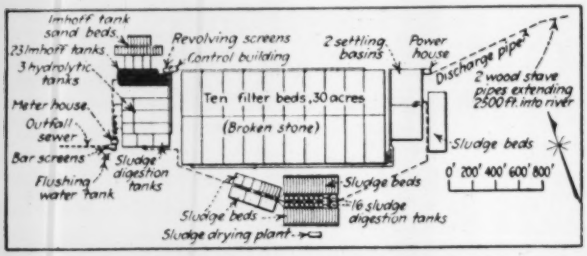


FIG. 1. GENERAL PLAN OF THE BALTIMORE SEWAGE-WORKS

with numerous requests for information have led me to prepare the following résumé of the operation of the Baltimore sewage-works from their first full year of use in 1912 to the close of 1920. To make the account more readily understandable an outline description of the plant will first be given.*

On April 7, 1904, the Maryland Legislature passed the sewerage enabling act which stated that the Sewerage Commission of Baltimore had no authority to construct any sewerage system which would discharge sewage, as distinguished from storm water or ground drainage, into the Chesapeake Bay or any of its tributaries. Accordingly the commission "resolved, that the effluent proposed to be discharged into the Chesapeake Bay or its tributaries in the system to be recommended by the engineers shall be of the highest practicable degree of purity."

To meet these requirements the Black River Disposal Works were constructed—and put into operation on Oct. 30, 1911. Additions have been made from time to time to care for the increasing sewage flow and at the present writing further extensions are under contract.

Description of Works—The existing plant consists of preliminary vertical bar screens spaced 1 in. apart; a meter house with five 42 x 21-in. venturi meters; 3 preliminary plain sedimentation tanks, known as hydrolytic tanks; 28 radial-flow Imhoff tanks, 19 separate sludge digestion tanks and 7.8 acres of sludge drying beds; 4 cylindrical revolving screens, trickling filter control house, 30 acres of trickling filters, 4 small pumphouses, each equipped with an electrically-driven centrifugal pump, a hydro-electric power house, generating power from available head in the treated sewage, and a final effluent conduit discharging into Black River.

The hydrolytic tanks are divided into two compartments by a curtain wall, the first compartment being 103 ft. 11 in. long by 101 ft. 9 in. wide and 10½ ft. deep, while the larger or secondary compartment is 313 ft. 9 in. long by 101 ft. 6 in. wide and 13 ft. deep. Both compartments have sloping bottoms.

The Imhoff tanks are circular. They were originally of the downward and outward radial-flow type, but some have since been converted to a radial horizontal flow. All of them are to be converted in this manner. These tanks are 39 ft. inside diameter, 13½ ft. deep to the bottom of the sedimentation chamber, and 27 ft. total depth. The sludge chamber is 23 ft. in diameter, with a conical bottom 5.3 ft. deep. The capacity of the sedimentation chamber is 8,920 cu.ft., and of the sludge chamber 3,663 cubic feet.

Of the 19 separate sludge digestion tanks three are 140 x 103 ft. 2 in. in plan and 13 ft. in depth and 16 are cylindrical tanks, 38 ft. inside diameter, 15 ft. deep to the conical bottom, which is 9½ ft. deep, making a total depth of 24½ ft.

Each revolving screen, open at one end only, is 12 ft. in diameter and 10 ft. long, weighs approximately 1½ tons and is constructed of well seasoned white oak. The stiffness is provided by ¾-in. steel tierods. The surface is covered by Monel metal cloth, 24 meshes to the inch, reinforced with No. 10 gage galvanized wire. Each screen revolves on a bearing at the closed end and on trunnions at the open end, and is driven by a 2-hp. motor.

The trickling filters cover an area of 30 acres, divided into 10 beds. They are filled to an average depth of 8½ ft. with 1- to 2½-in. hard broken stone. The stones rest upon slotted tile which covers the numerous underdrains leading to a larger underdrain and finally to the settling basins. These beds are provided principally with the Merritt square nozzles, although a few Taylor nozzles are still in use.

The flow onto these beds is regulated from the control house, which contains a constant-head chamber, valves electrically operated for turning on and off an entire three-acre bed, and butterfly valves for causing a fluctuation in the spray, which has a cycle of approximately four minutes.

*The principal articles on the operation of the plant heretofore published have been: "Operation of the Baltimore Sewage Disposal Plant," *Municipal Journal*, Nov. 2, 1916; "The Truth About Imhoff Tanks at Baltimore," *Engineering News-Record*, July 11, 1918, p. 84.

Summaries of the "Report of the Advisory Engineers of the Sewerage Commission of Baltimore" appeared in *Engineering Record*, July 28 and Aug. 4, 1906, pp. 101 and 129, and in *Engineering News*, Aug. 16, 1916, p. 177. A description of the experimental sewage-works built and operated to secure data for the design of the plant was printed in *Engineering News*, Feb. 28, 1907, p. 235, and the same journal for July 22, 1915, p. 164, described the activated-sludge experiments then being conducted.

Articles on design and construction are: "The Sewage Disposal Works at Baltimore," *Engineering Record*, Feb. 27, 1909, p. 237; "The Construction of the Baltimore Sewage Disposal Works," *Engineering Record*, Nov. 13, 1909, p. 545, and Nov. 20, 1909, p. 580; "Sewage Disposal Works at Baltimore," *Engineering Record*, Feb. 24, 1912, p. 201, and "Imhoff Tanks to Increase Capacity of Baltimore's Sewage Treatment Plant," *Engineering Record*, July 4, 1914, p. 4; "Additions to the Baltimore Sewage-Works," *Engineering News*, Aug. 5, 1915, p. 278; "Completion of the Sewerage System of Baltimore," Oct. 19, 1916, p. 736.

The settling basins are 275 x 290 ft. in plan and 10 ft. deep, with sloping bottoms.

The power house is equipped with two 150-hp. turbines. A direct connection to two 110-kw. generators is established by horizontal shafts passing through stuffing boxes in the wall of the building. The generators supply 2,300 volts to be stepped down to 220 and 110 volts. The power house is also equipped with a large switchboard, one two-stage centrifugal pump of 600 gal. per min. capacity against a 157-ft. head, and a gas engine which was used for driving one of the generators before the sewage flow was sufficient for operating the turbines continuously.

FIG. 2. THE BALTIMORE SPRINKLING FILTERS IN WINTER

The sand beds are of three distinct types. The original bed consisted of 30 in. of sand upon 6 in. of gravel, but because of poor drainage the sand depth has been decreased from time to time until at present it is 18 in. and drains satisfactorily. The setting-basin sand beds have a 12-in. depth of sand with no gravel except over the underdrains. The beds built in 1914 aggregate 5.17 acres and are constructed with 4 in. of sand on an 11-in. layer of gravel.

Normal Operation Methods—Baltimore has separate sewers connected to the sewage-works by a single large outfall sewer 30,370 ft. long, 12 ft. 3 in. wide and 11 ft. high. The sewage first passes through the bar screens, depositing an average of 35 wheelbarrow loads of rags, fruit peelings, sticks, etc., per day or 30 lb. of dry screenings per 1,000,000 gal. This material is removed by hand and sold to neighboring farmers. The liquid then continues on through the venturi meters, where it is divided, part going to the hydrolytic and part to the Imhoff tanks. The hydrolytic tanks are kept in operation until they show signs of undesirable septic action or until the laboratory analyses show the settling efficiency to be below normal. The supernatant liquid is pumped to one of the other hydrolytic tanks and the residual sludge is pumped into any one of the 19 separate sludge tanks. The Imhoff tanks, on the other hand, are run continuously except for a short interval every two weeks when about 600 cu.ft. of sludge is run out of each tank—producing good sludge. The effluents of the hydrolytic and Imhoff tanks discharge into the same channel and from there pass through the revolving screens. Here the finer particles which adhere to the under side of the screens are washed off by a continuous spray of purified effluent which has been pumped from the hydro-electric power house to a tower 128 ft. high. The return water from these screens is then run through two of the Imhoff tanks used temporarily for this purpose. A special tank to care for this return water will be constructed. The sewage then passes on through the control house to the trickling filter beds and from there through the final settling basins to the power house, thence through the land conduit, and is finally discharged into the river 2,500 ft. from the shore line.

The sludge from the hydrolytic tanks having been pumped into digestion tanks is removed from these when in the proper condition, spread upon the sludge drying beds to a depth of 12 in. and, when dry enough, is removed by cars to the Heineken Reduction Co.'s drying plant, where the material is dried still more, bagged and shipped for fertilizing purposes. The Imhoff tank sludge is removed from the drying beds by farmers who purchase it for 25c. per load.

There being two settling basins, one is cleaned while the other operates, the cleaning time being determined under conditions similar to those for the preliminary sedimentation tanks. These tanks are not normally cleaned as frequently as the primary tanks. When neither is cleaning both are in operation. The sludge from these tanks is either disposed of directly upon a sand bed provided for this purpose or, when not in the proper condition, it is pumped to any available sludge digestion tank.

Operation Results for Nine Full Years

Actual Operation 1911 to 1920 Inclusive—Although the above outline is the method of operation to which it is well to adhere, actual conditions have not allowed this procedure at all times. Therefore an attempt will be made to show just what the more important changes have been and at the same time figures will be presented to show the results of such operation.

On Nov. 6, 1911, the first quantity of sewage recorded as having reached the plant was 2,411,000 gal., the same being a seven days' flow. From this time on until February, 1912, no consistent records were kept but after the latter date both operation and laboratory analyses records were made regularly.

During these early days the plain sedimentation tanks were used as a dosing chamber, the trickling filters being operated but once a day and then only for a short interval. As more laterals were connected the fill-and-draw method of operation was abandoned and the continuous flow for one bed adopted. The 1912 records show an average daily flow of 11,800,000 gal., whereas the 1920 flow was 52,120,000 gal. per day.

Owing to the fact that the outfall sewer had been designed to care for 1,000,000 people at 150 gal. per day the first few years of operation with a small flow saw the deposition of considerable solid matter on the bottom of the outfall sewer, as well as a distinctly septic sewage to be handled. The former difficulty could only be overcome by cleaning the lower end of the outfall until such a time as the flow should become large enough to produce a scouring velocity. The cleanings were made about twice yearly, the last in 1916. At the present time, with a normal peak load of 69,970,000 gal., the deposit from the outlet end to a point two miles up stream varies from 4 to 28 in. The cleaning was ac-

complished in the following manner: An adjustable dam, in cross-section the same shape as the lower part of the sewer but 1 ft. less in diameter, was hinged to the rear of a scow (see *Engineering News*, July 22, 1915, p. 178). To take the scow up stream a rope was attached to it and a man in a rowboat carried the free end to the first manhole, where he tied it to the iron steps. Then the men in the scow pulled themselves up to this point. The same operation was repeated from manhole to manhole, the dam floating in a horizontal position. When ready to start cleaning the dam was placed in a vertical position and braced with guy ropes which could be quickly released if necessary. The rapid flow of water beneath the scow and dam scoured the deposit and as the water backed up the dam would be suddenly released, thus carrying the sediment along. This procedure was not abandoned because the velocity had become sufficient to scour, although there is considerable improvement in this matter, but was discontinued because the volume of sewage is at all times of such an amount as to keep the flow line too high to allow sufficient head room for the scow and workmen.

Hydrolytic and Imhoff Tanks

Preliminary Sedimentation or Hydrolytic Tanks—During the early years of operation the small volume of sewage received at the plant made it possible to clean the hydrolytic tanks every ten days to three weeks in the summer, and six weeks in the winter. When cleaned this often very little water had to be added to cause the sludge to run to the pump well from which it was delivered to the separate digestion tanks. This condition held because the scum had not had sufficient time to become thick and dry. At this time there was always one hydrolytic tank in service, one being cleaned and one in reserve. In June, 1916, the flow had become too great for one tank and a second one had to be placed in service for the peak load, making two in parallel. Although the Imhoff tanks began operating in August, 1915, it was necessary to continue the operation of two hydrolytic tanks, and eventually to run the two continuously in parallel. The reason for this will be mentioned when the Imhoff tank operation is considered. A gradual accumulation of sludge has put to use all the available storage capacity provided by the separate digestion tanks. This has resulted in less frequent cleaning of the hydrolytic tanks, which in turn has produced a heavy scum, pretty well dried out. This has of necessity increased the cost of cleaning because considerable water must be added to remove the scum and sludge to the digestion tanks.

Soundings made from 1915 through 1920 show that the cubic yards of 90 per cent undigested sludge produced per million gallons of sewage treated has been 5.70, 5.53, 7.34, 6.06, 5.14 and 6.37 for the respective years during this period. An average detention period of 3½ hr. produces the best effluent, and approximately 65 per cent efficiency, based upon settling solids removed, can be maintained under normal conditions.

Imhoff Tanks—The operation of the Imhoff tanks began in August, 1915, when 7 of the 28 were put into service. Each tank was "seeded" differently to determine the best method of producing well-digested sludge in the minimum length of time. Among some of the methods used was the addition of newspapers, lime, digested sludge, etc., but no advantage was found over the usual method of allowing the sludge to accumulate and digest in the natural way. Other tanks were gradually put into service until by March, 1916, all but two, which were reserved for activated-sludge experiments, were operating.

The tanks were operated at a low rate during the ripening period, which was rather long, but as soon as proper bacterial action seemed to have set in the rate was increased. Considerable trouble was soon experienced, with foaming and excessive scum formation. Sludge was removed as frequently as conditions would warrant, there being times when nothing but water could be drawn off, the sludge having gone to scum. The sloping walls were squeegeed by a regular attendant, but in spite of all this the scum in the sedimentation chamber at times reached a thickness of 2 ft. and more.

To prevent and quiet foaming a fire hose was used, but the best method was to shut the tank off from a few days to two or three weeks, during which interval skimming of the sedimentation chamber and spraying of the gas stack were usually resorted to. The tanks were then restarted very slowly.

Although these tanks were designed to treat 5,000,000 gal. each, per day, with a 50 per cent overload, the average maintained for about two years for 26 tanks was 4,800,000 gal. per day. That is to say, no more than this amount could be treated with a proper settling efficiency and without considerable scum escaping. At this rate, however, the average efficiency maintained was 61.6 per cent.

Imhoff Tanks Taken Out of Service

On June 6, 1917, the Imhoff system was taken out of service because, at this time, the volume of flow had become too great for one sedimentation tank and the Imhoff tanks with their limited capacity, and not enough for two hydrolytic tanks and the Imhoffs. That is, if the latter combination were used the detention period in the hydrolytic tanks would become so long that odors would be materially increased. Another reason for discontinuing the Imhoff tanks was one purely local and strictly of a hydraulic nature. Because of the excessive loss of head through the Imhoff system the water level in the large effluent channel leading to the revolving screens had to be carried a foot lower than when the hydrolytic tanks operated by themselves, thereby reducing the available area of the revolving screens very considerably. Furthermore, as soon as the head in the outfall sewer dropped below a certain elevation the Imhoff system would stop operating and then as the flow increased the water would seek its level through the hydrolytic tanks because of the less loss of head through them. In consequence of this the sewage would enter the Imhoff tanks backward, thereby disturbing the scum, pieces of which would leave the tanks for an hour or more after they had started operating. This condition also tended to overwork the revolving screens.

When the Imhoff system was discontinued the average daily rate of flow was 44,380,000 gal., but by 1919 this had increased to 55,060,000 gal. This made it possible to restart the Imhoff system by slightly increasing the detention period in the hydrolytic tanks. With this end in view two tanks were remodeled and put in operation in May, 1919, for experimental purposes. The results of a long period of experiment warranted to change being made in all the tanks. Accordingly this work was car-

ried on as rapidly as possible and by January, 1921, 18 of the 28 tanks were in service. The alterations consist of a raise in the flow line so that there can be no back flow into the tanks, reducing the number of weirs in the outlet channel of each tank from 52 to 35, reducing their depth to 1 in. and closing permanently all but one of the ports in the bottom of the influent ring around the gas stack. This one port is closed with a wooden plug to which is attached a long handle so that the same can be withdrawn once or twice a day to flush the sediment out of the influent channel. The changes as made cause the tanks to operate with a

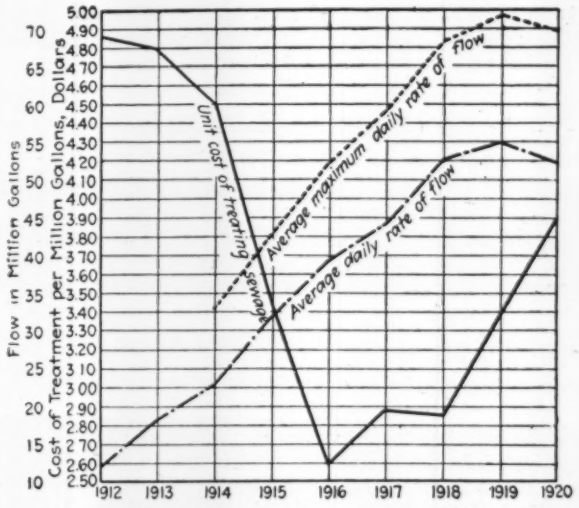


FIG. 3. DAILY RATES OF FLOW AND UNIT COST OF TREATMENT, BALTIMORE SEWAGE-WORKS

radial horizontal flow instead of a radial downward and outward flow.

The tanks now in operation give results practically as good as the two run experimentally, showing an average efficiency of 72.8 per cent, with a rate of 365,000 gal. per tank per day during 1920, as against 61.6 per cent, with a rate of 285,000 gal. under the designed method of operation.

Although they are not up to the designed capacity of 500,000 gal. per tank per day, it is the writer's belief that approximately this quantity could be treated if the hydraulic features were such that the tanks could operate the full 24 hr. instead of 20. It is interesting to note that with the revised tanks little scum has formed in the sedimentation chamber except for a short interval when the scum in the gas stack became so thick that it apparently short circuited and came up through the slot at the base of the flare wall. By removing some scum from the gas stack, thereby raising the bottom of the scum layer above the slot, this trouble was overcome. Very little trouble was caused by foaming, though when it did occur, it was easily controlled by the use of a hose for a few moments.

Revolving Screens—In 1912 two large revolving screens constructed of cast iron and steel, weighing approximately ten tons each and costing $9,645, were put in service. Because of their excessive weight they wore out the trunnions in ten days or less, whereas repairing the damage took about two weeks per screen. Thus they gave actual service less than half the time besides being very costly. After fair trial they were abandoned and the wooden screens designed by J. J. Neal, formerly superintendent of the plant, superseded them. As stated before, they were constructed principally of oak, were built with the plant force and weigh about 1½ tons each. There are four of these, the first of which was installed in January, 1914. The others have been built as needed and in consequence have cost different sums which may be stated as approximately $1,100, $1,500, $1,800 and $2,500, or a total of $6,900. They haxe given excellent satisfaction, no one screen having been out of service, on an average, more than two weeks per year because of mechanical difficulties. The Monel metal cloth is renewed from time to time and the screens are rewound with reinforcing wire. All told, each screen operates about 90 per cent of the time. The only important change in construction is the substitution of a 24-mesh screen for the 26-mesh since the latter has given trouble by clogging.

An idea of the efficiency of the screens is obtained by noting that when in service from 5 to 15 per cent of the sprinkling nozzles are cleaned daily as against 37 to 141 per cent when not running. As a result two men working eight hours daily are able to keep 30 acres of sprinkling filters looking well practically all the time. Furthermore, a series of analyses made in 1919 show that the return water from these screens contains 186 p.p.m. of suspended solids, consisting principally of surface floating material, such as grease, lumps of scum, etc. Approximately 100,000 gal. of purified sewage per screen is used daily for washing purposes.

Treated Effluent Used to Wash Screens

The purified effluent used as a spray on the revolving screens is conveyed to them by means of 2½-in. pipes placed horizontally over the uppermost part of the screens. As the screens revolve with the suspended matter adhering to the under side of the wire mesh the spray of purified effluent washes this material off into a trough beneath the spray, which returns it to the Imhoff tanks previously referred to. These pipes were formerly equipped with a number of nipples having ⅛-in. orifices and acted as a reciprocating arm by means of a cam attachment. The orifices clogged readily and were hard to clean and the reciprocating arm gave mechanical troubles. Because of these facts the arrangement described was replaced by stationary pipes with an 0.008-in. width slot cut on the under side. Any clogging is now easily removed by sliding back and forth through the pipe and on the under side of the slot a small V-shaped piece of metal attached to the end of a long pole. The material broken loose in this manner is then removed from the pipe by flushing.

The Trickling Filter Control House—This has operated continuously, as designed, except for one or two changes. The automatic float switches for operating the filter beds have been abandoned because the operator was not always present to record the changes as they took place. Now the switches are operated by hand whenever the water level in the channel leading to the control house rises above or falls below a given elevation. This arrangement also allows a better operation of the Imhoff and hydrolytic tanks in parallel. The loss of head through the operating gates leading to the control house constant-head chamber proved to be so great that one of these gates had to be opened permanently. The butterfly valves, driven by friction disks, have given excellent satisfaction although the

blades have been broken or washed away occasionally, which has resulted in minor changes of reinforcement.

The Trickling Filters—In 1912 the filter beds operated 30.69 acre-days per week as against 125.08 acre-days per week at present. As additional beds were required a new bed was ripened by using it for a short interval each day at the start, then gradually increasing the daily period until, after about six weeks, it would be found normal. After being ripened the beds would be so rotated that the new one ordinarily would operate at least one hour daily and was never idle more than three days at a time. They have sluffed regularly and apparently to such an extent that from all indications it will not be necessary to remove the filter stone for cleaning at the end of ten years, as predicted by the advisory engineers, and it is doubtful that they will ever need to be removed for cleaning purposes. The pipe line installed in the galleries, carrying purified sewage for flushing the underdrains, has not been used for this purpose. However, the lateral distributing pipes have to be flushed occasionally. This was originally done by opening the valves in the galleries at the end of each distributor and allowing the sediment to drain into a wooden trough which emptied into the filter channel leading to the settling basins. This method was not entirely satisfactory because of the splashing over the trough and into the small underdrains. Now the laterals are flushed by removing the nozzle at the end of each distributing line, leaving it off during two cycles of the butterfly valve and then replacing the nozzle. Thus all sewage passes through the filter beds. Occasionally it is necessary to flush out this section of each bed with a hose. The laterals on each bed are flushed about once every ten days.

Filter Operation

The cleaning of nozzles referred to when speaking of the revolving screens is accomplished by removing the nozzles and knocking the sediment off while the beds are running at the cleaning point, or at approximately one-third the quantity of regular service. At times of excessive flow, the butterfly valves are stopped entirely, so that the flow through the beds is constant and at its maximum rate, this being 1.39 times the normal rate. Although the advisory engineers recommended a rate of 2,500,000 gal. per acre per day the rate has varied considerably at times, but the yearly averages shown in Table I have been maintained with generally good nitrification.

TABLE I. AVERAGE YEARLY OPERATION DATA BALTIMORE TRICKLING FILTERS

Year	Rate of Filtration M. G. per Acre Daily	Nitrates, P.P.M.	Relative Stability Number
1912	2.73	8.3	93
1913	2.64	8.2	91
1914	2.72	7.2	78
1915	2.88	6.2	87
1916	2.84	4.4	93
1917	2.96	7.4	92
1918	3.00	8.1	96
1919	2.79	7.7	89
1920	2.91	7.0	92

In spite of the regular cleaning of the nozzles a thin scale forms on the under side of the deflector plate, altering the radius of the spray to such an extent that the scale must be removed. This has been accomplished in two ways, one of which can be done in warm or windy weather only. That is, the bed is allowed to be idle for about two days, when this scale becomes thoroughly dried. The flow is then turned on and the scale flushes off. This method is objectionable because of the strong odor arising from the bed treated in this manner. The other method is efficient but laborious. The nozzle is boiled in lye water, scrubbed with a steel brush and then replaced.

Two alterations have been made in the nozzles proper. The threads of the cast-iron nozzle plates had gradually deteriorated until the nozzle would no longer hold in place.

Instead of using new plates a threaded brass bushing has been placed in the plates needing this revision and their life seems to be longer than under the original condition. Approximately 4,000 of the 5,830 nozzle plates have been altered in this manner. The other change has been to cut the threads off of the deflector plate stem as they became worn and loose and to rivet the stem into the nozzle base.

Two Basins Run in Parallel

The Final Settling Basins—These basins, of which there are two, were recommended for a 3-hr. detention period, whereas actually the average for all the years of operation has been 6.04 hr. Originally it was possible to operate one basin while the other was being cleaned or held in reserve. As the flow grew larger it became necessary to run both basins in parallel. Then the loss of head through the mixing chamber and inlet valves to the settling basins proved to be so great that it was necessary to raise the walls of the channel leading to the mixing chamber, to build a bypass around it (to the settling basins) and to make additional inlet openings into the basins. It might be said, in passing, that the mixing chamber, originally installed for the addition of hypochlorite of lime, has never been used except experimentally, and then only once.

The Hydro-Electric Power House—This part of the plant has been operated as designed except for minor mechanical and electrical changes. When the plant first started it was necesasry to use the gasoline engine for generating electricity part of each day, but there has been sufficient sewage at all times since early in 1916 to allow the permanent closing down of this engine.

(To be continued in next week's issue)

Hydro-electric Development in Italy

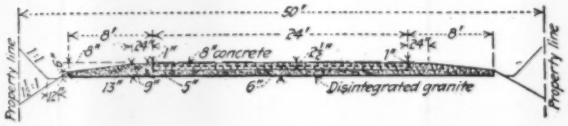
Commercial Attaché H. C. MacLean reports from Rome that during the war, in spite of the shortage of labor and the difficulty in obtaining equipment, hydro-electric development in Italy made rapid progress. It is estimated that whereas in 1915 Italy's electric power resources amounted to 2,500,000,000 kw.-hr. per annum, this figure had been increased to 3,700,000,000 before the end of the war, and now approximates 4,000,000,000. Whereas in 1915 the capital of Italian electric companies was less than 600,000,000 lire, it now reaches about 1,500,000,000 lire. During the five years from 1915 to 1920 there were completed new hydro-electric plants yielding 265,000 hp., and plants now under construction will yield 400,000 hp. additional. In these new undertakings it is estimated that approximately 1,200,000,000 lire will be invested. If studies now being made with the view to increasing further Italy's power resources are materialized an additional 1,000,000 hp. will be provided. Italy fully appreciates the exceptional value of its wealth with regard to water power.—*Commerce Reports.*

Special Concrete Highway Built for Motor Trucks

Methods in Laying Heavy Reinforced Section of Road Connecting Center of Los Angeles With Port District

AN 8-in. reinforced-concrete pavement 24 ft. wide is being laid from the center of the city of Los Angeles to the harbor for the express purpose of encouraging motor-truck traffic between the waterfront and the industrial districts of the city. The work is being done by Los Angeles County so no paving is being laid within city limits; a total of 13¼ miles is being built of which 7½ miles has already been completed. Features of the work are the methods used and care exercised to secure a very smooth dense surface. There are no sharp curves and the maximum grade will be 1.47 per cent. The total cost of the highway will be about $52,000 per mile, of which only a very small proportion is for grade separation and bridges.

The earth formation traversed is, for the most part, light sandy loam. After the roadway had been graded with fresnos a 6-in. layer of decomposed granite was brought in to serve as subgrade. This was alternately sprinkled and rolled, with a little spotting here and there, until it had been worked down to a compact surface. A subgrade planer, traveling on the header boards and carrying several V-shaped sets of knife edges whose



TYPICAL SECTION OF SUBGRADE AND PAVEMENT

elevation could be adjusted by means of quadrants, was then drawn behind the roller, grading the surface to about 1½ in. above the level desired as finished grade. This was then rolled down to exact level. Two rollers were used, one weighing 12 and the other 15 tons. Shaping the subgrade and setting headers is being done for about 25 cents per lineal foot.

The 2 x 8-in. header boards are spiked to 2 x 4-in. stakes driven every 4 or 5 ft. Reinforcing consists of ⅜ in. deformed square bars, spaced on 18 in. centers both ways. This reinforcing is wired together in sections 7 ft. long extending the full width of the road.

POURING THE LOS ANGELES-HARBOR TRUCK PAVEMENT

These short lengths were adopted after it was found inconvenient to have the reinforcement under the mixer. There is just room to place a 7-ft. section on the roadway behind the mixer and ahead of the finished section of concrete. Steel is lapped 40 diameters at joints.

A three-runner sled is used for holding the steel up off the subgrade. This sled is made of 7-ft. pieces of 2 x 6's held on edge at quarter-points of the road width by ½-in. spacer rods. The rods extend through the runners between which pieces of pipe, slipped over the rods, are used to keep the runners spaced as desired. The sled is attached to the mixer and moves forward with it, and as it comes just to the end of the mixer spout it always slips out from beneath the reinforcing just ahead of the pouring.

The concrete is mixed in the proportion of 1:2:4, using a well-graded washed gravel with a maximum size of 3 in. The materials are piled on the subgrade ahead of the mixer; the cost of unloading from freight cars and hauling to the job is about 35 cents per ton. With an 8-in. pavement it was felt that there would be better opportunity to avoid air pockets and secure a uniformly dense mass if the mix was made rather wet as compared to the mix usually used for thin slabs. The mixer is advanced 3 to 4 ft. at each move. The only expansion joints used are those put in at the close of each day's run. They consist of asphaltic compound ½ in. thick.

Two mixers are used. One taking a three-sack batch has a crew of 22 men that ordinarily places about 175 ft. of completed pavement in 8 hours. This crew is distributed as follows: 1 mixer man, 1 finisher, 1 finisher's helper, 2 tampers, 2 spreaders, 8 wheelers and shovelers, 1 cement dumper, 1 material man, 1 chute man, 2 placing reinforcement, 2 covering and watering. The other, a 4½-sack-batch mixer, using a crew of 26 men averages about 325 lineal feet of completed pavement per day with the crew organized as follows: 1 mixer man, 1 finisher, 1 finisher's helper, 2 tampers, 2 spreaders, 12 wheelers and shovelers, 1 cement dumper, 1 material man, 1 chute man 2

TWO-MAN LONGITUDINAL FINISHING FLOAT WORKED FROM BRIDGES

SHOWING POSITION OF SLED AND CONSTRUCTION OF TEMPLATE

placing reinforcement, 2 covering and watering. The largest yardage poured with the 4½-sack mixer in an 8-hour run advanced the pavement 371 lineal feet.

The template for finishing off was made 12 in. deep and well trussed to insure retaining the 1-in. crown on which the surface is finished. It weighs about 240 lb. In placing the concrete care is taken to keep the space between the header boards so filled that the template will carry at least 2 in. of concrete ahead of it. After the template, a hand roller is used to smooth off the surface. This roller, which is made of sheet iron, is 7 ft. long and weighs about 80 lb. It is drawn from side to side by ropes manipulated by men standing on the road shoulders. The roller is ordinarily passed over the surface twice.

The next operation is done with a two-man float worked from a pair of bridges spanning the roadway and from each of which a man can walk from header to header while working the float with a sawing motion parallel to the center line of the road. This float is worked across the road, keeping the advancing edge inclined slightly upward to rise over irregularities, until all traces of corrugations are removed. The float ordinarily moves, say, ¾ in. of concrete ahead of it. Successive operations of this float are made to overlap about 2 ft. to secure a continuity of the finish it gives. The float is made as light as possible so as to avoid bringing an excess of water to the surface. This float is 12 ft. long and 6 in. wide with a vertical rib in the center of its back. It is faced with light sheet iron.

Finally, a steel trowel is used to retouch the surface where the float may have left any irregularities. The finished pavement is covered with water, retained in the usual way with dikes and checks, which is left on for 14 days. Traffic is permitted after 21 days.

The work is being done by force account by the Los Angeles County Highway Commission under the direction of George W. Jones, road commissioner.

SUBGRADE PLANER CUTS SURFACE TO WITHIN ONE AND ONE-HALF INCH OF DESIRED GRADE

Drainage Canal at East St. Louis

To intercept the hill water which flows into the bottom lands around East St. Louis, Ill., a canal is being built along the foot of the bluffs by the East Side Levee and Sanitary District, this canal connecting with the Prairie du Pont diversion channel which is nearing completion and discharges into the Mississippi River. As the levees of this channel are above the highest known flood level of the river, this disposal of the water will avoid the necessity of pumping the run-off from 80 square miles of hill territory.

The 11½-mile canal will have a low-water channel 11 ft. deep with 50-ft. bottom and 1 on 2 slopes, making a top width of 94 ft. On each side will be a 50-ft. berm to the levees, which will be 20 ft. high above the berm, with 12 ft. top and slopes of 1 on 2 and 1 on 3 for the canal and land sides respectively. This will give widths of 194 and 274 ft. between the toes and tops of the levees.

Contracts have been awarded to A. V. Willis & Sons and H. J. Sternberg, St. Louis, for the two lower sections, Nos. 1 and 2, 18,800 ft. and 17,200 ft. respectively. Two dragline excavators with 100-ft. booms and 3½-yd. buckets are now at work. These two sections will cost about $1,500,000, including right-of-way and bridges. The total cost of the entire three sections is estimated at $2,621,000, of which $1,621,000 is for the canal and levees and $1,000,000 for highway and railway bridges. E. R. Rodenberg is chief engineer of the East Side Levee and Sanitary District. This diversion canal was considered in the plans proposed by Alvord & Burdick, consulting engineers, Chicago, as described in *Engineering News-Record* of Oct. 30, 1919, p. 815, but it was recommended as a future supplement to a canal across the district and having a pumping plant. As the railways would have to pay a part of the cost of this latter work but are not financially able to provide the necessary funds at this time, the District has decided to proceed with the diversion canal as the first part of the project.

Radio Replaces Telephone Lines on Remote Construction

Avoids Line Maintenance Under Snow and Ice and Establishes Dependable Communication Quickly at Low Cost

TWO large hydro-electric construction projects are now being carried out by California power companies on which sole dependence is placed on radio as a means of communication. Both these jobs are in the High Sierras where the country is extremely rough and broken and where snow and sleet conditions very unfavorable to telephone line maintenance obtain in the winter time. The report of both companies is that the use of radio has been a pronounced success and will be continued as a permanent feature in their construction programs.

The Southern California Edison Co. in extending its system of generating plants in the Big Creek and San Joaquin River districts found it necessary to maintain reliable communication service between Cascada, the construction headquarters at the end of the railroad, and two other points farther back in the mountains. Natural conditions were not favorable for radio communications because Cascada is in the head of a canyon approximately 2,000 ft. deep with abrupt walls on three sides, and the other two points are 7 and 15 miles distant respectively in an air line, and are separated by a range of mountains 10,000 ft. high.

Experiment Showed What Was Required—Because of the high altitudes and the meager information available about radio communication in mountainous territory, considerable experimenting was done before the type of radio equipment to be used was selected. That these experiments were well justified was shown by the fact that sets which gave satisfactory service in the level country around Los Angeles were found to require about ten time more power for transmission over corresponding distances in the rough, high mountainous country. Continuous wave sets radiating 2½ amperes antenna current gave louder and clearer signals than damped wave sets radiating 4 amperes antenna current, and the former were adopted. The sets operate on a 540-meter wave length and the design is such that either telephone or telegraph may be used. The use of the telegraph was found to be the more practicable because of the comparative stability of the transmitting set as well as its greater range under unfavorable atmospheric or topographical conditions. The masts for the antenna at all three stations consist of tall pine trees stripped of their branches.

Means of Supplying Power

The set at Cascada obtains its power from the generating plant located there, while the field sets are supplied by 220-volt, 3-phase motors, coupled to direct current generators wound for 32 volts and 1,500 volts respectively. Under normal conditions the 32-volt generator furnishes power for the filament and the 1,500-volt generator serves the plates of the thermionic tubes used in these sets. In case of failure of the transmission line which supplies both the field camps, power for the radio sets is supplied by the storage batteries of the mine locomotives which are in use at both camps. In this emergency the 32-volt generator is operated as a motor and drives the 1,500-volt generator. In case of a breakdown of either the motor or the generators the radio sets may still be used for telegraphic operation by means of a switching arrangement which makes possible the use of alternating current on both filaments and plates.

The success which has attended the operation of these sets during winter months under conditions where company officials regard it as doubtful if a metallic circuit could have been used, has led to very satisfactory reports of the use of radio sets and additional studies and investigations are now contemplated. During December, 1920, with the operators on duty 8 hours a day, approximately 32,000 words were handled between Cascada and the first field camp. This included a considerable amount of private commercial communication. The company has announced that a radio station somewhere near the proposed Colorado River development is planned so that direct communication may be maintained between that point and the general offices in Los Angeles, a distance of some 400 miles.

When the San Joaquin Light & Power Corporation last year undertook the construction of the Kern Canyon hydro-electric development, 125 miles from the headquarters office in Fresno, descision was made to place entire dependence on radio. Within a month after this decision was reached two 2-kw. sets, one at the site and one at Fresno headquarters, were installed, the total cost for the two stations is stated by company officials to have been approximately $750.

The Damped Wave System

The transmitting equipment at both stations is the spark or damped wave system. Ordinary distribution transformers of 2-kw. rating are used to raise the voltage from 220 to 6,600. Other parts of the equipment were purchased from radio manufacturers and assembled under the direction of power company engineers. The receiving apparatus is the self-contained cabinet type supplied by any one of several manufacturers.

In the absence of an alarm or calling device, a schedule of operation is fixed for the day each morning; the operator coming on at the beginning of the day and after clearing all business in hand, setting a time for the next period of communication. Ordinarily there are about half a dozen intervals during the day when the two stations are in communication. While not actually operating the sets, the operators are kept busy at the drafting table or some other clerical work.

Thus far, under all weather conditions, the operation of these stations has been very satisfactory, power officials report, despite the necessity for erecting the aerial at the site not far from a high tension line from which some inductive interference was unavoidable. This company is also operating, in an experimental way, two radio telephone stations and has begun the assembling of portable radio sets which are to have a range of 25 mi. and will be used to keep the various construction camps in communication with the main or base camp during the construction of the Kings River hydro-electric generating station. The latter camp will be equipped with a larger radio set intended for constant communication with the Fresno head office. The prospects are, company officials state, that during the construction of extensions to this company's system in the mountain regions, radio will hereafter be depended upon as the chief means of communication.

Railway Bridge Construction and Service by American and European Standards

Higher Unit Stresses Used by European Designers—Soft vs. Hard Metal—Rigidity and Heavy Bracing of American Practice—A Comparative Impact Test with European and American Locomotives

BY P. H. CHEN
Engineer of Construction, Tientsin-Pukow Line, Chinese Government Rys., Tientsin, China

WHEN the writer came back from America about two years ago, he was very much interested in studying the present condition of bridges in China. To his great surprise some of the bridges, rated according to American standards, have a capacity of only about E10 to E30, while the engines now in service range from E30 to E45. This led the writer to compare the standards and specifications of American, French, British, Belgian, and German practice. Finally, the writer investigated the effect upon bridges of the locomotives manufactured in different countries.

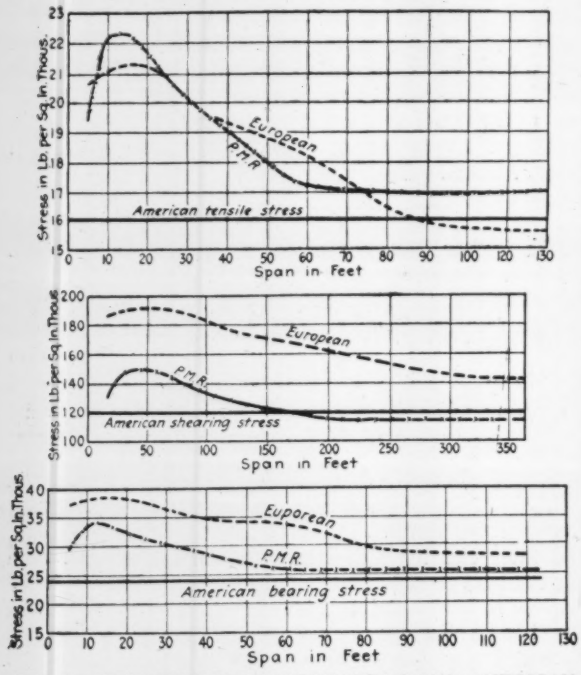


FIG. 1. UNIT STRESSES OF EUROPEAN AND AMERICAN BRIDGE PRACTICE COMPARED

The specifications and standards for bridge structures of different countries proved to be a great puzzle. The principal points of perplexity are those which effect strength and rigidity under railroad service.

Unit Stresses—European unit stresses seem to be high. Many people think that Europeans do not take impact into consideration; others hold that impact is covered by the allowed unit stresses. But it appears that the low unit stress used by Europeans is not low enough to equalize the impact allowance of the American formula, especially in short spans. The writer has taken live load, dead load, and impact into consideration in analyzing European allowable unit stresses, and the results are shown in the three diagrams reproduced herewith as Fig. 1. The excess of the equivalent European unit stress over the American is 40 to 60 per cent on short spans. It should be observed particularly that these large percentages affect the stringers and floor beams of every through bridge. This and some of the following matter are taken from a paper which the writer recently presented before the Association of Chinese and American Engineers.

The allowable shearing stress in continental Europe is 90 per cent of the tensile stress, or about 19,000 lb. per sq.in. as a maximum. In bearing, a maximum stress of 1.8 times the tensile stress or about 38,000 lb. per sq.in. is considered allowable. Rivet holes are sometimes taken as equal in diameter to the rivets. For these reasons stringer and floor-beam connections in European design seem to be weak.

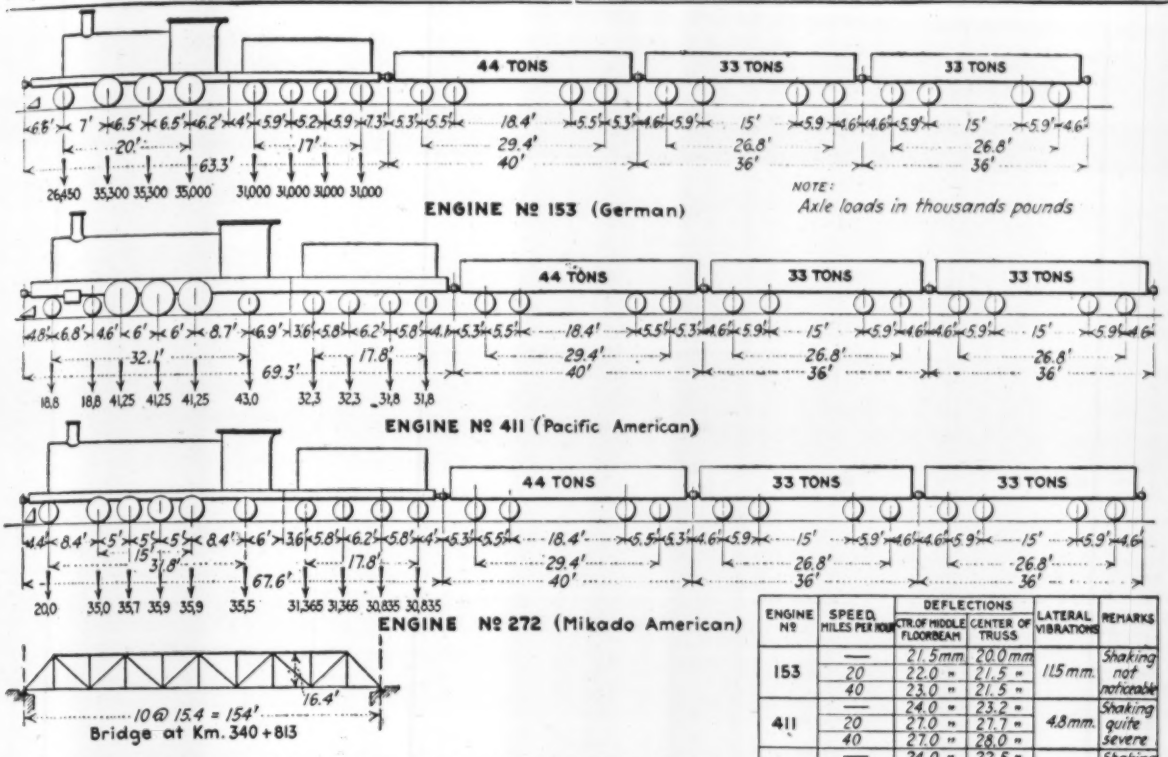
Quality of Material—Some people think that European structural steel is of better quality than the American, inasmuch as European specifications prescribe higher ultimate strength. In the writer's opinion, the tensile strength to be specified depends on the amount of impact produced by traffic: If the American impact allowances are correct, the soft steel is desirable, while traffic that produces less impact would permit the use of higher carbon steel. American practice uses high-carbon steel for long span bridges, where impact action is small.

Bridge Types—Pony trusses are quite popular in continental European practice, while in America they are generally considered unreliable for railroad structures. It seems to be considered that any severe lateral vibration produced by passing trains might tend to throw out of line the top chords, with long column action and lacking bracing, and that this would reduce the degree of safety of the structure.

Rigidity and Bracing—The writer is greatly surprised to find marked differences in top-chord bracing between European and American designs. A corresponding difference is found in truss depth, and in general proportioning and rigidity of construction. This is represented by the accompanying cross-section of two bridges (Fig. 2), both in service, having the same span length and designed for almost the same live loads. The European bridge, at the left, seems to be weak and wanting rigidity; it is braced on top with only one 3 x 3 x $\frac{3}{8}$-in. angle, without cross struts, while the American bridge is braced with two heavy struts, a full lateral system, and kneebraces. Moreover, the American bridge has a much greater truss depth, and the transverse frame is rigidly connected at both upper and lower corners.

As appears at once from the drawing, the European bridge seems weak and slender, while the American bridge looks stiff and rigid. Undoubtedly, Americans use a great deal more metal for bridges of the same span lengths with identical live loads.

Differences in Locomotive Impact.—The impact effect of three different locomotives on a 150-ft. bridge was measured by the writer on Feb. 17, 1921. The vertical



ENGINE Nº	SPEED, MILES PER HOUR	DEFLECTIONS: CTR. OF MIDDLE FLOORBEAM	DEFLECTIONS: CENTER OF TRUSS	LATERAL VIBRATIONS	REMARKS
153	—	21.5mm	20.0mm	11.5mm.	Shaking not noticeable
	20	22.0 "	21.5 "		
	40	23.0 "	21.5 "		
411	—	24.0 "	23.2 "	4.8mm.	Shaking quite severe
	20	27.0 "	27.7 "		
	40	27.0 "	28.0 "		
272	—	24.0 "	22.5 "	7.0 mm.	Shaking very severe
	20	27.0 "	29.5 "		
	35	26.0 "	24.5 "		

Effect of Three Engines on 114-Ft. Bridge

FIG. 3. IMPACT TEST OF 150-FT. BRIDGE WITH THREE LOCOMOTIVES
Vertical deflections and lateral vibration measured at different speeds.

deflection and the lateral vibration was measured, as recorded in the table included in Fig. 3 herewith. Though the work was done with crude instruments, the results were strongly in favor of European locomotives. The most astonishing thing was the severe lateral vibration caused by American locomotives. The writer is trying to continue the investigation with more accurate instruments.

Before the world war China used no American locomotives, and accordingly the bridges were designed to Belgian, French, British, or German standards. The Peking-Hankow line was the first Chinese line to try American engines; two severe bridge accidents resulted. The American engines which caused these failures were actually lighter than the French engines still in service. Bridge engineers design their structures so as to bear the traffic with a certain factor of security. If the locomotives of different countries differ, naturally the bridges are likely to differ correspondingly. This may tend to explain the differences in the bridge practice of different countries. As regards China, however, it is an unfortunate fact that it has bridges and locomotives designed for entirely different conditions.

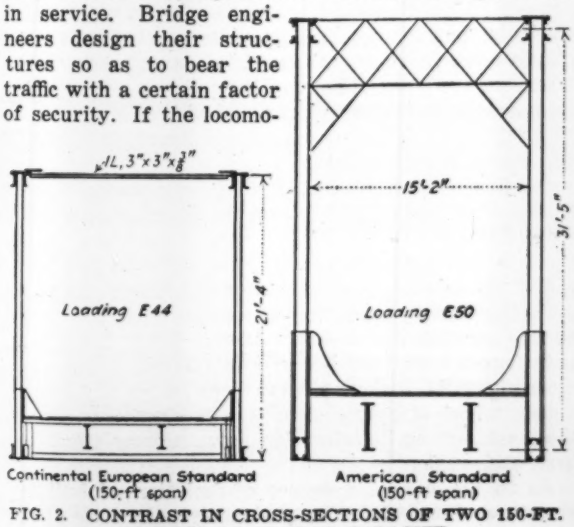


FIG. 2. CONTRAST IN CROSS-SECTIONS OF TWO 150-FT. BRIDGES OF SIMILAR CAPACITY

If engine designs could be improved so as to reduce impact, there might be a great saving in cost of bridge construction.

Questions Concerning Bridge Design.—The reasons for the wide difference in standards and specifications above referred to should be investigated. The American impact formula is certainly correct, as it was derived from the results of stress measurements, and has been carefully checked by a great number of well known engineers. On the other hand, the unit stresses of European practice must also be correct, because European engineers also have measured the actual stresses in bridge members.

Specific questions that present themselves are:

1. If American practice is correct, how can European bridges endure long service without signs of failure?
2. If European practice is correct, why do Americans waste so much money in building heavy structures?
3. If different conditions require different standards and specifications, how should Chinese practice be fixed for best efficiency and economy?

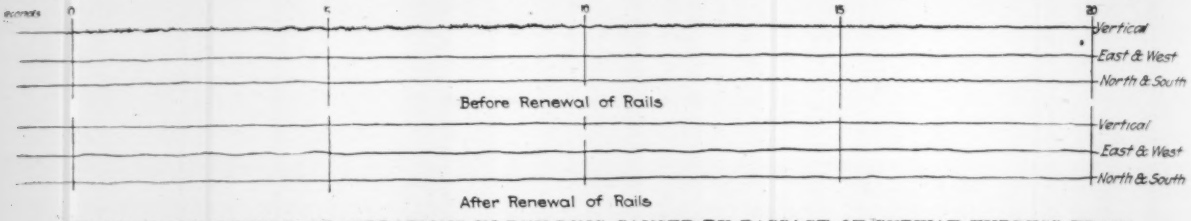
Erie Reciprocating Pumps Should Have Lowest Cost

In a brief summary of the paper on the water-works of Erie, Pa., by J. N. Chester, published in *Engineering News-Record*, June 16, p. 1043, reciprocating pumps should have been credited with operating at lower cost than centrifugal in the four-day working test outlined in Mr. Chester's paper.

Negligible Vibration Effects from Subway Traffic

New York and Philadelphia Experience Indicates Occasional Rumbling and Tremor But No Structural Effect

INFORMATION received from the transit departments of New York, Boston and Philadelphia in answer to inquiries as to whether structurally harmful vibrations originate from subway traffic and are transmitted through the ground to adjacent buildings indicates that no such effects occur. It was suggested by the report on the collapse of the Strathmore apartment building in New York (*Engineering News-Record*, Feb. 17, 1921, p. 315) that some kind of vibration might have been the immediate cause of the collapse, although the looseness of the structure of the building was ultimately responsible. As a rapid transit subway line passes the building, and the possibility that vibrations transmitted from the track might have played some part in the disintegration of the building, inquiries were addressed to the authorities of New York and Philadelphia as to their experience and observation of any possible effects of this kind.



SEISMOGRAPH RECORD OF VIBRATIONS IN BUILDING CAUSED BY PASSAGE OF SUBWAY EXPRESS TRAIN
Curves taken both before and after changing of worn rails in track are shown. The record shows the movement at greatly magnified scale, being twenty times that of the actual movement of the structure. Practically all of the vibration was vertical.

Summarizing the experience so developed, it can be said that twelve to seventeen years' experience with many thousands of buildings of all kinds of foundation, type of construction and structural condition, located along high-speed subway lines, show no case of any disintegration or other discoverable harmful effect of subway traffic on adjacent structures. Only in relatively few cases is there audible rumbling or sensible tremor (vertical vibration). This evidence is essentially negative, but the large number of cases it covers makes it significant. Further, several buildings alongside New York subway lines, on soft-ground foundations, which had settled badly out of plumb due to actions occurring prior to subway construction or operation, show no effect of years of subway operation, either in increase of settlement or in evidence of disintegration.

In New York subway operation, according to Robert Ridgway, engineer of subway construction, a few cases of complaint of rumbling occurred early in the history of operation, and some cases also of alleged shaking or high frequency tremor. All these cases were investigated. E. G. Haines and A. D. Prince, of the engineering organization of the Public Service Commission, studied many or them by a seismographic recorder of the pendulum type, designed and built by the latter for the purpose. With the help of the records furnished by this instrument it was possible to eliminate numerous cases in which the effects complained of were not due to the subway but to the operation of pumps or other machinery in the buildings themselves, producing distinct lateral vibrations, usually of low frequency. In a few instances, as the Times building, the instrument demonstrated that vertical tremor occurred on the passage of trains. The tremor had a frequency as high as fifteen or twenty complete vibrations per second, and correspondingly small amplitude, the largest amplitude measured being about 0.004 in. vertical motion (in the middle of a floor panel). It was found in the case of the Times Building, which is located directly over a sharp curve in the subway line with its columns close to, though on separate footings from, those of the subway framing, that most of the disturbance arose from rail corrugation, and was largely eliminated when the corrugated curve rails were renewed.

Motions of the same order were recorded in several Brooklyn theater buildings where noise or tremor was complained of, though here the principal trouble occurred on the basement (ground) floor, which was concrete on the natural earth. In Carnegie Hall, in Manhattan, a faint sound is heard in the auditorium from the operation of the new Seventh Ave. subway alongside, but nothing has been observed in the way of vibration. Under similar circumstances, in the Academy of Music, a Brooklyn theater, a slight instrumental record was obtained, but no sound, from the operation of the Flatbush Ave. subway, 200 ft. away. The last example illustrates the transmitting power of the ground, in this case sand.

Slight noise and occasionally sensible vertical vibration occur in one or two Brooklyn locations, also in sand (e.g., Joralemon St.). In similar locations, several complaints have been made, at different times, of a jarring effect of passing trains, that became noticeable suddenly, not having been troublesome before. Such effects were in all cases traced to a roughness of the track, such as a wheel burn of the rail head or a similar irregularity, and ceased on removal of the defective rail. The seismograph curves reproduced herewith illustrate the nature of such records.

On Fourth Ave., Brooklyn, there are several houses that are as much as 10 in. out of plumb (on a four-story height). These houses, whose condition is the result of settlement in construction, prior to the building of the subway, have stood now for nearly ten years with the subway operating alongside, with no change or any complaint of injury. At this point the subway is in four-cell reinforced-concrete structure. Many other cases along the various subway lines in the city involve houses whose structural condition is suspicious, to say the least, but no deterioration from subway effect has been observable.

As to the desirable degree of isolation of building structures from the subway structure, the view of the engineering staff of the Transit Construction Commis-

sioner of New York is that it is desirable to avoid direct contact. Complaint has resulted both in sand and on rock where steel or concrete parts of the two structures were rigidly connected; the connection apparently enabled high-frequency tremor to communicate from the railway structure to the framework of the building, so that the tremor is perceptible in the building.

Philadelphia experience is just as conclusive that no injury to structures results from proximity of rapid-transit subways, according to H. H. Quimby, chief engineer of the Philadelphia Department of City Transit. Even with buildings in very poor mortar, Mr. Quimby states, no injury results. He expresses the opinion, however, that if both building and railway roadbed are on soft clay or a mud bank, vertical vibration may be transmitted into the building, with the possibility of harmful effect to the latter.

Effect of Surface Traffic

Surface street traffic produces the most sensible effect in buildings, Mr. Quimby has observed. Street cars with flat wheels or trucks rolling over rough pavements set up lateral vibrations which strike the foundation walls of a building sideways and tend to set up lateral vibrations of the structure. Studies that have been made in preparation for planning subway lines under theaters or similar buildings have led to the conclusion that no effect on the service of a theater is to be apprehended, and that practically all disturbing traffic effects complained of in various buildings are traceable to street traffic action.

In Boston the subject of vibration in buildings has been considered repeatedly, according to Ernest R. Springer (chief engineer of the city's transit department.) Twelve years ago the subject was given special attention, as summarized in the 14th annual report of the Boston Transit Commission (1908):

As a considerable portion of the Washington St. tunnel lies directly under private buildings, experimental study was given to the question of preventing annoyance to the occupants by sound and other vibrations caused by the running of trains. Among the means thought of were: (a) Building the track on separate foundations, like piles or piers, passing through the invert or floor of the tunnel and having little or no connection with said floor; (b) Substituting for the ordinary stone ballast some other support for the track itself, such as concrete made with portland cement or with asphaltic material.

Consultation on this general subject was had by letters with A. Mallock, who had made a careful study of vibrations in buildings near the Central London Ry., and directly with Prof. C. R. Cross of the Institute of Technology and with Prof. George W. Pierce of the Department of Physics of Harvard University, and others.

Mr. Mallock did not expect any benefit to result from the above named plans. His belief, based on his extended study and experience, was that relief was to be expected almost entirely from having the weight of the trains, as far as practicable, borne on springs. When trouble occurred on the Central London Ry. the non-springborne load of the locomotives there used amounted to about 8 tons per wheel, while with the motor cars which will run in the Washington St. tunnel the maximum non-springborne load will be only about 1½ tons per wheel.

Among other experiments a radial truck was used, with a non-springborne load, revolved by an electric motor on a circular rail, the latter having forms of support (a) and (b) mentioned above. Experiments were also made with standard cars, running on about 200 lin.ft. of track. The relative effects of various experiments were measured directly with the ear; also by observing with a telescope with cross wires the movements of an image on a surface of mercury; with the vibration instrument of Mr. Mallock and with the sound measuring apparatus of Prof. Pierce. The information obtained indicated that sound or sensible vibrations coming from the tunnel were much less likely to be noticed by occupants of buildings than vibrations caused by teams and cars on the surface of the street. It also appeared that the support of ties by means of ordinary stone ballast was nearly or quite as good as any form tried, and accordingly that method has been used in all parts of the Washington St. tunnel.

Summarizing all the experience in Boston before and since that time, Mr. Springer says that in general, although rumbling sounds are occasionally noticeable at some points, the effects in the way of vibrations in buildings are negligible. The first subway has been in operation for 24 years, and no complaints of vibration due to the operation are recalled. This first subway has been used largely for trolley cars, although for a while a portion of it was used for elevated trains.

The East Boston tunnel, used entirely for trolley cars, has been in service for 17 years. The Washington St. tunnel, used exclusively by elevated trains, has been in use for 13 years, and although it lies largely under private buildings there have been no complaints of vibration; rumbling sounds have been noted at certain places, however. The Boylston St. subway, carrying trolley cars exclusively, has been in operation for 11 years. The Dorchester tunnel, and the tunnel under Beacon Hill connecting with the Cambridge subway, has been used by subway trains made up of the heaviest type of car. This tunnel is built through very compact ground, composed largely of sandy clay containing small stones, and so hard that dynamite was used in the excavation. A slight rumbling sound may be heard when trains pass at a point near the westerly portal, where the cover over the roof is only 2 ft. No vibration has been noted, however.

Copper-Bearing Steel in Atmospheric and Immersion Corrosion Tests

Exposure tests of numeorus samples of sheet iron and sheet steel conducted by the committee on Corrosion of Iron and Steel of the American Society for Testing Materials have progressed so far that the committee was able to report at the society's last meeting (June, 1921) that "copper-bearing metal shows marked superiority in rust-resisting properties as compared to non-copper-bearing metal of substantially the same general composition, from which superiority we may truly anticipate a marked increase in the service life for copper-bearing metals under atmospheric exposure of uncoated sheets." This conclusion was essentially based on the samples exposed at Pittsburgh, where, in 22-gage thickness, the percentage of failures among the non-copper-bearing sheets was as high in sixteen months (35.7%) as in copper-bearing sheets at forty-one to forty-six months (27.4-44.5), and the copper-bearing sheets in fifty-two months had fewer failures than the non-copper-bearing sheets in twenty-two months; and in 16-gage thickness the copper-bearing samples showed no failures after fifty-two months, while 43 per cent of the non-copper-bearing sheets of this thickness had failed. Supporting this series of tests, however, the committee finds that "the light-gage, non-copper-bearing bessemer and openhearth metals which failed first at Pittsburgh have also failed first at Fort Sheridan," where another series of exposures was made.

Emergency Levee on Mississippi Built in Record Time

Only Seven Weeks Required to Throw Up 240,000 Yards at Trotters Front for Protection of Yazoo Delta District

BY A. L. DABNEY
Consulting Hydraulic Engineer, Memphis, Tenn.

CONSTRUCTION of an emergency levee or loop 6,000 ft. long with an average fill of over 17 ft., containing 240,000 cu.yd., in seven weeks last January and February, was the result of the Yazoo-Mississippi Delta District being threatened by the continued caving of the river bank below the old levee at Trotters Front. At one time there were 1,040 mules on the work handling 184 wheel scrapers (with necessary "snap" and plow teams) and 116 "four-up" wagons. At the rate of work during maximum construction it would only have required twenty-eight working days to build the entire levee. The extent of the work and the caving of the old bank is shown in Fig. 1. A profile of the actual fill required for various stages of the emergency loop, or curtain levee, is indicated by Fig. 2. Sections of existing and emergency levees are shown in Fig. 3.

Occasions still arise when flood protection on the Mississippi River demands heroic measures. Such demands formerly were more frequent and exacting than now, and some of the accomplishments in earlier years bordered on the picturesque. Thus in 1897 when levees generally were below standard, the "Upper Yazoo" Levee District hastily raised fifty miles of its lines with temporary topping one-half to three feet high, keeping barely above the rising flood. Since that time the entire system of levees has been raised and increased in section, and except for a nominal cost for maintenance, there would be little further expense but for caving river banks.

A caving bank at Trotters Front, which suddenly assumed an alarming aspect, made necessary the building of an emergency levee; and probably the record for rapid levee construction has been made in the building of this "loop," now about completed. More than a mile of new levee, containing 240,000 cu.yd., was built by teams in about seven weeks. In one month nearly a mile of caving bank was revetted with temporary willow mats 75 ft. wide.

The emergency levee or "loop" is 6,000 ft. long, with average fill 17½ ft. It was built through woods where clearing and grubbing of the base and most of the borrow pits was necessary. One-fourth of the line is through cypress swamp, the fill ranging from 20 to 25 ft. for a distance of 1,200 ft. A series problem was drainage for the work, which had to be provided. Practically the entire work was accomplished between Jan. 1 and Feb. 15, 1921.

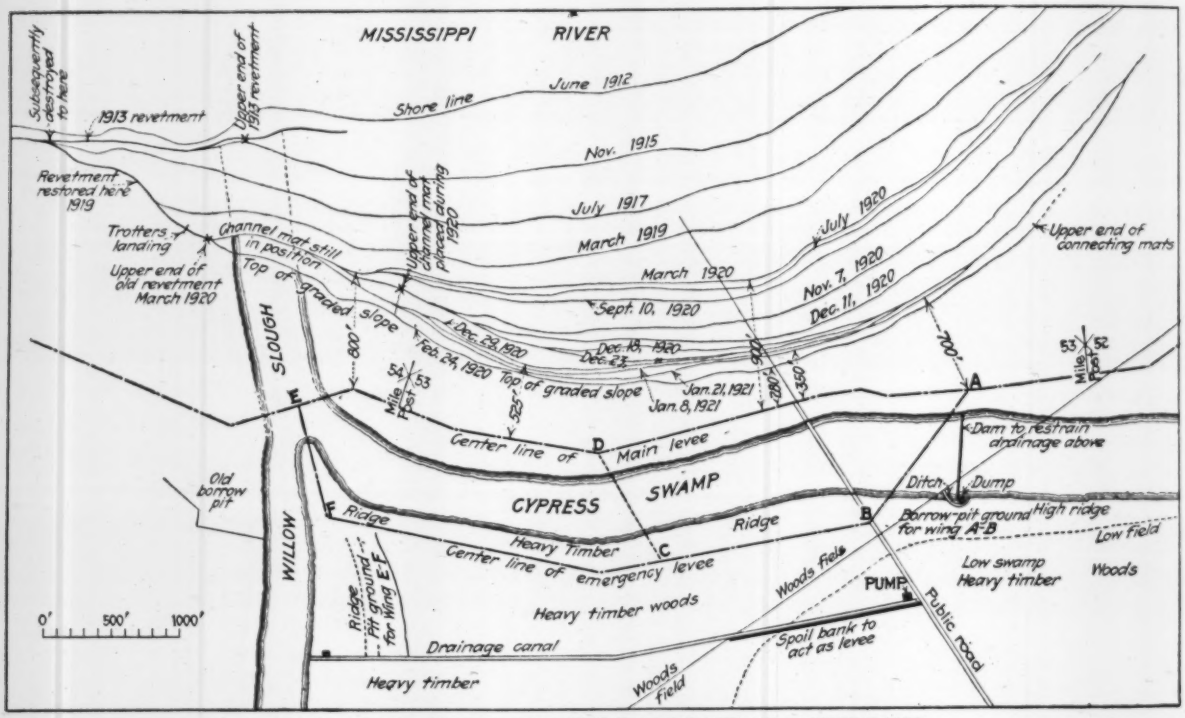


FIG. 1. EMERGENCY LOOP LEVEE BUILT BACK OF CAVING BANK

The levee, where threatened by this caving bank, is about midway of the system, 100 miles long, of the Yazoo-Mississippi Delta Levee District. This system protects 2,370,000 acres of valuable "delta" land, 550 miles of railroad and a number of prosperous towns. The total assessed value of property in the district (for state and levee taxes) is $115,000,000. A break here would have been a calamity.

In the past, many miles of new levee have been built to replace levee that caved into the river. The Federal Government has not, as yet, generally applied revetment to caving banks; although much revetment work has been done in isolated bends. For some years there has been concern for the integrity of the levee line at several caving bends in this district. The appropriations by the Government were insufficient to revet these bends as speedily as necessary to save the levee line,

and the Levee Board, in 1912, began a policy of contributing to the construction of river bank revetment on its front. Up to this time the Levee Board has contributed $962,500 for revetment work and there are now 6½ miles of permanent revetment, most of which was built under this co-operation. The Government furnishes the plant, does the work and pays part of the cost. The extent of revetment that can be built in a season has been limited by both funds and the size of available plant; hence only the most critical bends have been treated.

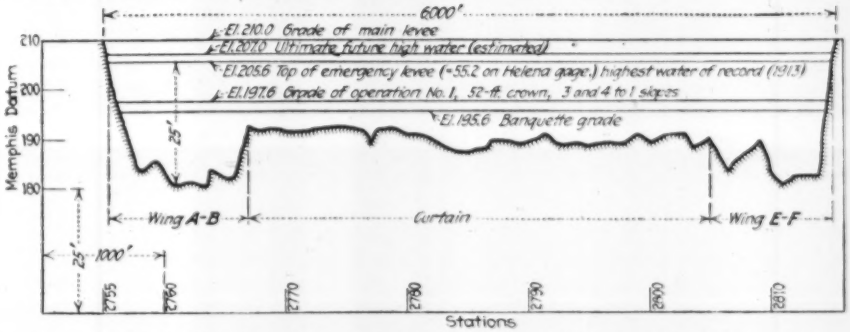


FIG. 2. PROFILE OF EMERGENCY LEVEE AT TROTTERS FRONT

While the bank along Trotters Front has been caving for many years, it was neglected because of more exacting demands elsewhere. In 1913 nearly a mile of revetment was built a short distance below the emergency levee, and in 1919 this was extended upstream to nearly opposite its lower junction, point *E* in Fig. 1.

It will be seen on the map that for a mile above the 1913 revetment, the bank caved, from 1912 to 1920, at a fairly uniform rate, averaging about 200 ft. per year, and that in March 1920, caving had advanced to within 800 ft. of the levee center at the nearest point.

It was designed to extend the revetment upstream, from the 1919 work, as far as practicable during the season of 1920, the Levee District paying $100,000 of the cost. It was expected that the season's operation would cover about 4,000 lin.ft. Because of the general labor shortage, normal progress was not made and up to November the extent of bank covered was only about 1,500 ft.

Early in November, it became apparent that the caving had assumed an accelerated rate. The river was at a low stage and the extension of a sandbar opposite had resulted in confining the water to a comparatively narrow channel against the concave bank. The bank here is sand from its top to below water. After this development the revetment plant was moved about 4,600 ft. upstream, from which point it was expected to work back. Three weeks were expended in futile efforts to get a mat down. Deadmen for anchorage cables would be placed as far as 100 ft. inland, and would cave off before the mat could be completed and sunk. It was then decided to rush the building of "connecting mats" along the threatened front, and a second fleet was ordered here to aid in this work. By Feb. 1, 1921, the connecting mats were continuous from the permanent revetment to above the upper junction of the loop. They were made 75 by 250 ft., the short dimension being transverse to the shore line. Before this work was finished, the bank had moved to within 350 ft. of the levee center. A persistent "Pocketing" above the mats, and grading to a slope, has since brought it within 280 ft. Construction of a second line of connecting mats, overlapping the first, was afterward undertaken.

The rapid caving, the small margin remaining and the uncertainty about holding the bank with the temporary revetment, made it imperative that steps be taken, at whatever cost, to build a loop behind the threatened levee. As first located (Dec. 23, 1921), the loop was 3,600 ft. long, the lower junction being at *D*, Fig. 1. During the next six days after this location was made, the bank 600 ft. below *D* caved, 140 ft., to within 525 ft. of the levee. It was then decided to extend to a junction at *E*, making the total length 6,000 ft. The extension was located about Jan. 1, 1921.

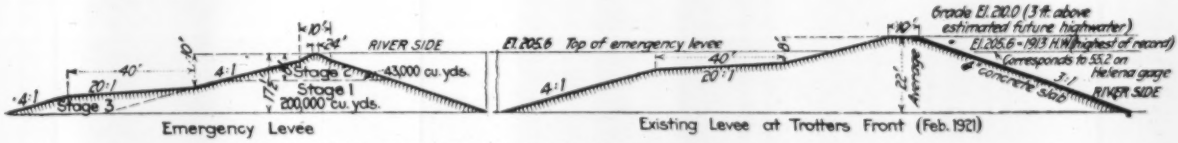


FIG. 3. TYPICAL SECTIONS OF EMERGENCY AND EXISTING LEVEES

Occasionally the river rises above its banks in January; more often in February or March. This year, on Jan. 3, the stage at Cairo was about 20. The records show that in six years out of the last twenty Cairo reached 20 before Jan. 15 (including once late in December). On each of these six rises, Helena reached 37 (bank-full) before Feb. 20 (three times before Feb. 1). Three times, 47 at Helena was reached before Feb. 15. Evidently, then, if the main levee should be lost, only a few weeks could be confidently counted on for completing the emergency levee.

The consideration of speed in construction governed largely in the location. The line was placed far enough back to be safe for this season (probably longer). Inland from the adopted location the ground becomes lower; and to have lengthened the loop at either end would have increased the quantity of embankment, the length of haul and the borrow pit difficulties. The lower junction is protected by the permanent revetment. If necessary the two fleets could concentrate on the point opposite the upper junction and hold it. The caving was much lessened along the upper half of the threatened front after the river had risen sufficiently for a considerable volume to flow across the sandbar. As a result, very rapid caving occurred on the lower half.

The levee was built by team forces; 2-mule wheel scrapers and 4-mule dump wagons filled by traction-drawn loaders. The first force was moved to the site on Dec. 19 and began embankment work on Dec. 24. Prior to Jan. 3 comparatively little embankment had

been built; but progress had been made in clearing. On that date, at a conference of the chief engineer and consulting engineers of the district, it was decided that sufficient force must be employed to finish the levee by March 1, and that the work should be divided into two operations; the first being to build the entire line to an elevation 8 ft. below grade; the second, to complete it to grade. "Grade" is the top of the "topping." In this district the standard section has 10-ft. crown at grade, and any extension above this crown is regarded as a "topping" above grade. The banquette would be built afterward. If a pronounced rise should occur in the upper rivers, the entire line was to be rushed to grade-minus-eight at about half base width, and afterward widened. The borrow pits had been laid off, of liberal area, and drainage canals planned along their back side. One canal drains north and one south from about midway of the work. The south canal drains by gravity unless Willow Slough should rise. The north canal had to be pumped for every rain. It was decided to rush to completion the clearing of base and pits over the entire line, to employ as many teams as could be worked without congestion and to assign an engineer for the sole duty of keeping the borrow pits in such shape as always to drain promptly. All borrow pits were worked out beginning at the back. There were available two centrifugal pumps, total capacity 2,500 g.p.m. These were held for the south canal. For the north canal 3,000 g.p.m. pumping capacity was purchased (to handle 3-in. runoff per 24 hr.).

Record Construction

It was estimated that during January and February 26 working days could be counted on; and that the force must be made adequate to complete the work within these months. All forces then in the district were moved to this work and all available forces for some fifty miles above and below the district were secured. About 40 per cent of the force was from other work within the district. All forces were paid by the day. The maximum force was at work on Jan. 22, and consisted of 184 wheel scrapers (with necessary "snap" and plow teams), and 116 'four-up" wagons. There were 1,040 mules working on the maximum day, or more than a mule to every 6 lin.ft. of levee. There were 7 tractors and loaders at work.

The two "wings," involving long haul, were assigned to wagon forces. On the "curtain," the embankment was divided among the scraper forces. For assigning the work so that all parts of the line would be completed at about the same time, so that in handling the distribution of forces there was no crowding nor confusion, and for handling the borrow pits so that work was always resumed the next day after a rain, much credit is due the chief engineer and resident engineer of the work. Stage 1 was completed, on the curtain, Feb. 6; on the wings Feb. 18. Stage 2 was completed, on the curtain, Feb. 15; on the wings, Feb. 24. Construction of stage 3 (the banquette) was then undertaken with a greatly reduced force.

The season was more favorable than was expected, resulting in the loss of fewer days from rain. The actual time was 27 working days for stage 1, and 7 for stage 2. At the rate of work accomplished per team, the full force would have built the entire line in 28 working days. The longer time resulted from the delay in building up the force to maximum.

W. M. Gardner, U. S. assistant engineer, had charge of the revetment work, under direction of Major J. N. Hodges, Corps of Engineers, U. S. A. W. J. Shackleford was superintendent of the revetment fleets and forces. Major T. G. Dabney is consulting engineer and W. L. Head, chief engineer of the Levee District. Mr. Head was immediately responsible for engaging, assembling and distributing the forces. A. T. Blythe was resident engineer in direct supervision of the levee construction. The writer was called in consultation by the consulting engineer and chief engineer of the district and was in close touch with the work throughout.

Highways Policy in Britain

THE British Ministry of Transport has issued the tenth annual report of the road improvement fund covering the year to March 31, 1920. A grant was authorized in December, 1918, by the government to assist highway authorities to cover arrears in road and bridge work which had accumulated during the war. The fund devoted to the road and bridge program for 1919-20 amounted in all to £10,536,000, of which £10,000,000 was allocated to Great Britain and the remainder to Ireland.

Few authorities were able to complete their programs owing to the difficulty of obtaining materials. A large proportion of the money has gone toward the improvement of roads in and about London, the borough councils receiving roughly £1,000,000.

In the meantime the Road Improvement Association has criticised the ministry's delay in making grants to local authorities for road improvement and maintenance on the ground that, although nearly £8,000,000 has been gathered in motor taxation, none of this amount has so far been allocated. In reply the director-general of roads says that the financial year of the local authorities began on April 1, and that, as grants are only to be made quarterly and not in advance, the first payment is not due until July 1.

The system suggested on which payment should be made is that the certificates of expenditure of the local authorities, when passed by the Ministry of Transport, will be honored to 90 per cent, the remaining 10 per cent being paid at the end of the financial year.

A sum of £1,250,000 has been allocated to the arterial roads scheme, and £1,750,000 for main roads during the current year will be borrowed from the Treasury.

Some concern is felt for the future road policy in England. It is generally believed that the Ministry of Transport will cease to exist with the decontrol of the railways which is due next August. In some quarters it is suggested that the roads department be taken over by the Board of Trade, as the general policy of road construction is widely approved.

It is fast becoming evident that the growth of road transport has overtaken the existing highways, and it is urged that some authority must be created to control and pursue the laying out of new arterial roads, the co-ordination of road construction and repair and maintenance of roads on a national basis.

Engineering Courses Should Be of Professional Grade

Prof. Wm. H. Burr Argues that Technical Study Should Be Preceded by Three Years of General College Work

As stated in the News Section of this journal last week, the leading feature of the annual meeting of the Society for the Promotion of Engineering Education was a paper by Prof. Wm. H. Burr, formerly professor of civil engineering in Columbia University, and now in consulting practice in New York, arraigning the society for neglecting its opportunities and urging that engineering education be put upon a "professional" basis, that is, that it be preceeded by three years of liberal study in college. The paper, printed here somewhat condensed, warrants close study and discussion by practicing engineers and by engineering educators. We should be glad to print their views in these columns.—EDITOR.

One may reasonably be surprised, if not bewildered, in looking over the *Bulletins* issued by the Society for the Promotion of Engineering Education and the annual reports of the same body, to observe both the range and the quality of the observations made for the purpose of advancing the efficiency of engineering education. Indeed, both the scope and the range of subjects covered by these observations are so far-reaching and so varied that one wonders whether there is any point of stability in the whole field. The variety of suggestion and the range of subjects from the most fundamental and important to the inconsequential and commonplace seems to indicate that no two individuals, whether teachers or practicing engineers, have any substantial thing in common. In other words, the whole field of engineering education seems to be in a dynamic condition, or perhaps one may better put it as a state of violent ebullition without any surface evidence of having stable strata at any depth whatever.

Professional Status

For some reason members of the principal engineering societies and associations of this country are deeply dissatisfied with their professional status as indicated by the failure of the public, as they claim, to give members of the profession proper consideration in their professional work. There have been many meetings, joint and individual, of these societies and associations, for the purpose of discussing this failure to receive sufficient professional recognition from the community at large. New organizations have been created recently to secure better professional recognition.

Doubtless much can be done to relieve this situation among experienced practitioners, but the greatest influence is that which can be exerted through suitable and effective professional educational training. If the Society for the Promotion of Engineering Education had had as a body a true vision as to what it could and should have done in developing wholesome and effective ideas of engineering education, it is not unreasonable to suppose that the present unsatisfactory and disappointing condition of the profession could have been prevented. This was the proper mission of this society and it has failed fundamentally in it. * * * This society owes to itself the recognition of an obligation to reform as far as it can the present conditions of engineering education and undertake the organization of some systematic effort to ascertain what engineering education really means so as to formulate an effective plan for rescuing it from the morass of technical confusion into which it has fallen.

At the present time, and therein lies the origin of all our difficulties, the colleges and the professional schools of engineering are made a hopeless jumble which has received the constant sanction and support throughout all these years of this society. A great majority of the engineering schools of the country are called "colleges of engineering." Obviously the mere name of an educational intsitution is of quite subordinate consequence in itself. "A rose by any other name would smell as sweet," as we know. In the present instance, however, calling a professional school an "engineering college" makes a course of study which ought to be thoroughly professional in character merely a scientific college course, and that is the fatal defect of a great majority of the engineering schools of this country. They are neither professional schools nor are they in reality colleges. They are a kind of hybrid that produces neither the broadly educated college man, nor the educationally trained professional man. Some of them have served well a transition purpose, but the type is far from that of a professional school.

More than seventy years ago the oldest engineering school in America, Rensselaer Polytechnic Institute, reorganized its professional course of study with a vision as to the future both wise and remarkable. It sought to establish a professional school of engineering and applied sciences by formulating a course of wholly professional study of three years' duration to which college graduates were invited to come for their professional engineering training. It was fully fifty years in advance of the time when such an effort could possibly succeed. The experiences of the first year of this course of professional study showed that it then had no prospect whatever of success. To remedy the difficulty a preparatory year of study was formulated so that non-college graduates could thus prepare to begin the three-year course of professional educational work, making four years in all. This was the origin of the prevailing four-year course of engineering study which has become so general throughout the United States. It would appear that the idea of basing professional engineeering educational training on a broad general schedule of study such as that afforded by the usual college course has somehow dropped out of all consideration whatever, except in a few rare cases. There is distinctly a feeling that something needful is not included in the present engineering courses even in the minds of those who administer and defend them, and their apprehension is too well founded. There is something of the utmost importance lacking. Both students and instructors of those institutions yield, although unconsciously, incontrovertible evidence of that fact. It is only necessary to glance over the *Bulletins* and annual reports of this organization to be convinced of this situation.

If the Society for the Promotion of Engineering Education should advocate a definite, well-considered plan of professional education for engineers and direct its support to such a plan through its annual meetings and publications, it would give confidence and inspiration to the professon and thus greatly influence its reception in at least the leading engineering schools of the country.

Comparison With Law and Medicine

I am well aware that many engineering instructors and practicing engineers who are interested in engineering education argue that the engineering profession is in some way so different from the learned professions of the law and medicine in its character that the general type of educational training which they have adopted for entrance into

those professions, is not suitable for the educational training of young engineers. They now require in their best professional schools a broad general education acquired in the college on which to base the professional educational training. Anyone who is observant enough will find that a large proportion, and probably the majority, of those two professions who have reached the beginning of middle life, are men, broadly speaking, not only of technical ability and excellence but who possess what may be termed in the broad sense, cultivation. They can take their places with credit to themselves in any place in the community where they may be called. They possess individuality and those qualities of mind and character which demand and receive public recognition both in and out of their professions. It is not necessary to eniarge upon the lack of such acknowledged position in the community on the part of engineers for they themselves have set it forth within the past few years in clear and unmistakable terms. All such curative efforts made through engineering organizations, however, are bound to fail in large part as they have failed up to the present time, unless one fundamental condition is first fulfilled and that is, the engineer must have a full professional education as a basis for his professional career before he can properly demand or be accorded by the public, full professional standing. Indeed, if it were feasible to give every engineer in the country a suitable professional educational training the profession would in a short time attain to the high position which it covets and be accorded by the public every advantage which it is now striving to attain without any other aid whatever, just as the professions of law and medicine have done.

The high position and the great advantages reached by any profession are actually due to the acknowledged character and attainments of a majority whose capacity and character make them marked individuals and whose prestige gives standing to the entire profession.

Introducing Six-Year Course

The four-year course of engineering study has served a purpose and served it well but, I believe it may be stated without being effectively controverted that by far the best results have been reached where the course of engineering study has been based upon the broad course of general educational training given by colleges. I know that the usual standard objection will be made that there are few young men in the community who have sufficient time and means to take seven or eight years for such a course of study. In the first place it may be flatly stated that young candidates for law and medicine find it feasible to devote sufficient time for the desired purpose and I know of no reason why young candidates for the engineering profession may not do the same thing if they have sufficient virility, resolution and, I hesitate to say, intelligence. In the second place, I can state from personal knowledge and experience that seven or eight years are not required. Six years are ample, three years in the college and three years in the engineering school. If our secondary schools were administered a little more intelligently it would be not only perfectly feasible but easy, as it has been in many cases, to give a young man this six-year engineering course of study and graduate him ready to begin his active practice at twenty-two years of age, which is a less age than that at which many and perhaps a majority of young men graduate from the standard four years' engineering course.

In the case of the four-year course, the student not having had any prior general education at a college or elsewhere, it is probably wise to introduce as much English instruction during the first year as is practicable. A similar observation can properly be made in reference to one prominent modern language such as French or Spanish. Such general cultural subjects, however, should be limited to the first of the four years, and as soon as the required development permits the installation of a prior general education in a college of cultural or liberal arts work these subjects should be confined to that part of the educational training, leaving to the professional school the entire time set apart for technical work. Doubtless in some or even many localities it may be a considerable period of years before it would be feasible to reach the full professisonal educational training consisting of a broad general education of not less than three years, leading to the professional school having a course not less than three years in length, but that is the end toward which all possible efforts should be directed. College courses taking no more than three years' time are now common. It has been demonstrated over and over again in some of the most prominent colleges in the country, and it has further been demonstrated by actual operations, that in that college course mathematical and and scientific studies may be taken to such an extent as to include all similar subjects found in the first year of the best four-year courses, thus completing in a three-year course in the professional school all the educational work now comprised in an engineering course of the highest grade. The complete educational training from college entrance to graduation from the professional school thus covers a period of six years only. Actual administration of such a course has already shown that it is entirely feasible to carry on at any educational establishment of the higher order the four-year course and the six-year course in parallel, so to speak, making it entirely feasible to maintain the full attendance of the four-year course in addition to students who are taking their educational training on the six-year basis. Naturally in such a case, as many legitimate attractions as is possible should be given to the administration of the six-year course so as to encourage the growth of that part of the professional school to the greatest extent practicable. In such a case it would not be necessary to drop the four-year course until such time in the future as the attendance on the six-year schedule would justify it.

It is no exaggeration to state that the hope of the future of the engineering profession in this country lies in the development of a proper professional engineering education which with exceedingly few exceptions has not yet been attained. There is no field in which this society could gain prestige or render greater service to the engineering profession and to engineering education than to take formal action in the encouragement of this development. The position of the legal and medical professions point the way with absolute clearness. The engineer must be made a man of cultivation as well as of technical excellence. In order that he may become the most useful citizen possible he must combine with his rather narrowing technical excellence those qualities which give him character and standing as an individual qualified to win the esteem and respect of those about him for his executive capacity wherever he is found to possess the executive quality. In other words, he must be a man entitled to receive the confidence of the community in which he practices.

Co-operative Reconstruction in France

During the last year the co-operative movement in the devastated regions of France has made considerable progress; in fact, at the present time the greater part of reconstruction work is executed by such societies. Both the government and the population of the devastated localities have found these methods of the greatest practical value. Furthermore the government encourages their organization and development. Since the beginning of 1919, 203 co-operative societies have been organized in the Department of the Meurthe-et-Moselle. They have already obtained important results. On Dec. 31, 1920, urgent repairs had been made on approximately 12,000 buildings. The sums disbursed for these repairs amounted to 124,430,000 francs, or 81 per cent of the total sum paid out for this purpose in the Department. In 1920 the co-operative societies commenced the building of 621 farm buildings, or 88 per cent of the total in the Department. The sums disbursed for the above purposes amounted to 20,250,000 francs, or 95 per cent of the total.—*Commerce Reports.*

Automatic Single Rope Cableway For Material Handling

AN AUTOMATIC single-rope cableway, requiring but one hoisting cable for its operation, and operating on a track cable stretched between two towers, is being used in the automobile manufacturing plant of the H. H. Franklin Manufacturing Co., Syracuse, N. Y., for storage and rehandling of coal.

The operation of this layout is essentially as follows: A track cable is stretched on a slope between two towers. Upon this cable rides a carriage to which a clamshell bucket is suspended by a bale. The hoisting line extends from the engine over a sheave at the top of the tall tower, commonly called head tower, beneath the track cable to the carriage, over a sheave

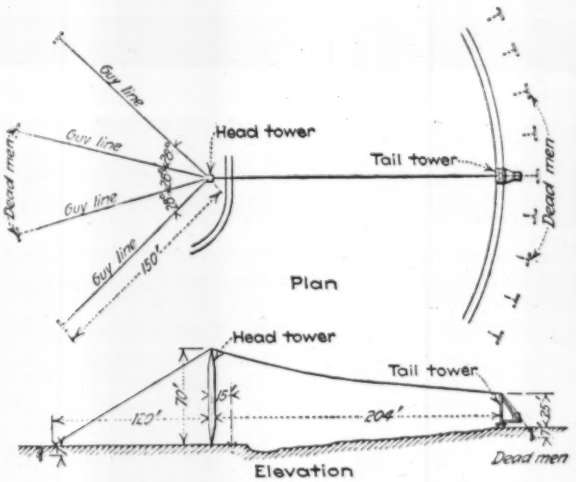


FIG. 1. GENERAL LAYOUT FOR INSTALLING AUTOMATIC SINGLE ROPE CABLEWAY

in the carriage, through the bucket and back to the carriage where it is made fast. When this line is paid out the carriage-carrying bucket suspended below is moved down the track cable until it reaches the lower stop.

When there, a latch on the end of the carriage automatically engages the stop, the bucket bale is released, and the bucket is lowered by further paying out of the line. A pulley upon the line closes the bucket and lifts it with a load of material. When the bucket bale enters the carriage it is locked thereto and the carriage is automatically released from the stop, so that it is free to move upward along the track cable until it encounters the upper stop. The line is then paid out, the carriage engaging itself to the upper stop and releasing the bucket which is lowered.

As in use in the Franklin plant, the tail tower is an A-frame mounted on a car which runs on a track that describes a circular arc about the head tower. A fan-shaped storage space for coal is then provided. The length of track cable between towers is 220 ft. A drawing showing the layout of this installation is shown in Fig. 1.

The bucket may grab a load beneath either stop, but it cannot leave the carriage between stops. To shift the point where the load is taken it is necessary to shift a stop. This is made an easy matter by providing hand lines from the stop reaching to the ground. When these are pulled the clamps that hold the stops from

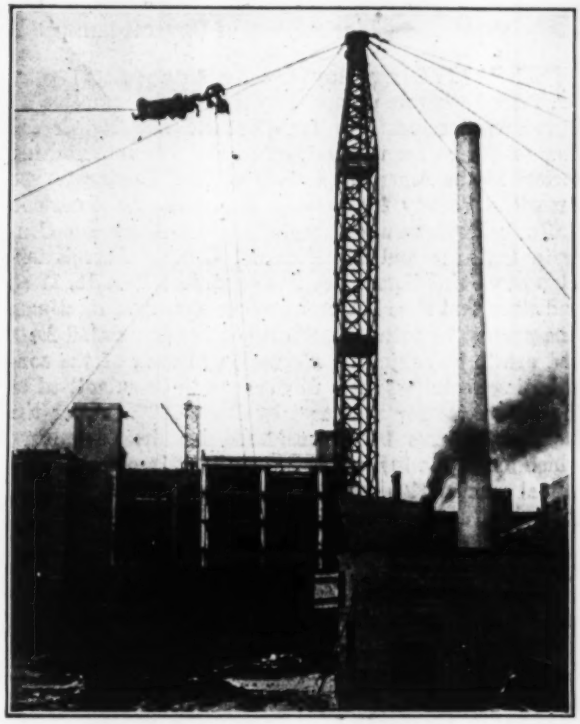


FIG. 2. DISCHARGING A BUCKET LOAD AT THE FRANKLIN PLANT

slipping along the track cable may be tightened or loosened.

Any hoisting engine or motor capable of lifting one-half of the weight of the load bucket may be used, but the speed of operation depends upon the size and speed of the engine, and if a new hoist is to be purchased for the installation it should be capable of high sped.

The information contained in this article is given by Blaw-Knox Co., Pittsburgh, manufacturer and distributor of the automatic single-rope cableway herein described.

Formulating Tire Specifications for the Government

According to a statement issued by the Bureau of Standards, standardization and revision of the government specifications for rubber tires are in progress, under a procedure explained as follows: On April 8 a meeting was held at the invitation of the Motor Transport Corps, where the different tire companies as well as seven government department and four boards or commissions were represented. Ways and means for revising government tire specifications were discussed. Specifications prepared by the Bureau were submitted, and in discussion various changes were suggested. It was decided that a copy of the specifications together with the recommended changes should be sent to the Rubber Association of America for consideration and possible further revision. On return of the revised draft a second meeting is to be called for further consideration of the problem. It is understood that the Bureau will issue the final specifications as a desirable government standard for rubber tires when the views of all interested parties have been considered.

Joint Committee's Tentative Concrete Specifications

Preliminary Draft Differs From Earlier Reports Mainly in Leeway Allowed in Proportioning, Emphasis on Workability of Concrete and in Details of Column and Flat-Slab Design

TENTATIVE specifications for concrete and reinforced concrete prepared by the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete have been submitted to the five contributing societies—the American Society of Civil Engineers, the American Society for Testing Materials, the American Railway Engineering Association, the American Concrete Institute and the Portland Cement Association. This new Joint Committee was organized Feb. 11, 1920, and since that time has been having numerous meetings. The present tentative specifications are in printed form and are to be subject to discussion in each of the contributing societies, these discussions to be submitted to the committee for reference by June, 1922. After the discussions have been considered by the committee, which meantime is meeting regularly, it is expected that a final specification will be prepared for the approval of the constituent societies.

Specifications

Preparation of specifications, was not considered a part of the duty of the Joint Committee that presented its final report in 1916. The present committee states in the preface to its report that it has "undertaken to prepare specifications covering the fundamentals to be observed in the general use of concrete and reinforced concrete. No attempt has been made to cover the details involved in the use of these materials in special structures. While the sections relating to design deal primarily with building construction, nevertheless the principles involved are in general applicable to structures of other types. It is expected that in using these specifications the necessary supplemental requirements will be added covering details." Furthermore, there are in the tentative specifications several alternative sections, which in some cases represent a difference of opinion on the part of the committee and in others represent equally good methods, any one of which may be used by the engineer using the specifications.

The specifications are prefaced by a list of definitions, which do not differ from accepted practice except possibly in the regular use of the adjective "portland" modifying cement wherever it is used in relation to concrete.

Under the heading, "Quality of Concrete" it is stated that "quality shall be expressed in terms of workability as determined by the slump test and of the compressive strength at 28 days as determined by concrete tests of the materials to be used as specified." The proportions required to produce concrete having the strength specified shall be determined in advance of the mixing of the concrete. No definite strengths, such as were in the earlier report of the committee, are given.

Under the heading, "Materials," portland cement is defined by the A. S. T. M. standard specifications. Fine aggregate has the same general definition as in the earlier report, but is recommended to be graded as follows: not less than 95 per cent through a No. 4 sieve; not more than 30 per cent through a No. 50 sieve, and not more than 3 per cent weight removed by decantation. Fine aggregate must show a compressive strength at 7 and 28 days not less than that of 1:3 standard Ottawa sand mortar of the same plasticity made with the same cement, but a new sentence is added which states that fine aggregate which fails to meet this requirement may be used, provided the proportions of cement, fine aggregate, coarse aggregate and water are such as to produce concrete of the strength specified. The Abrams-Harder colorimetric test for organic impurities in sand is specified but sand which shows a darker color than the standard color when tested according to that method may be used if the concrete made with the materials and in the proportions to be used on the work is shown by test to be of the required strength.

Coarse aggregate is defined as "crushed stone, gravel, or other approved inert materials," with the usual characteristics but a grading is submitted with blanks to be filled in, although a table gives desirable gradings for a coarse aggregate for certain maximum sizes.

Nothing radical is in the sections on "Rubble and Cyclopean Aggregate," "Storage of Aggregate," and "Water." The section on "Metal Reinforcement" allows both billet steel and rail steel bars as provided for in the specifications of the American Society for Testing Materials, except that the provision for machining deformed bars before testing is eliminated. A footnote gives preference to billet steel pins. Sizes and areas of reinforcement bars are specified according to the standards developed during the war and since then accepted by the American Concrete Institute. A sentence states that "an approved deformed bar shall be one that will develop a bond strength at least 25 per cent greater than that of a plain round bar of equivalent cross-sectional area," but a footnote reads "The committee has under consideration a specification for deformed bars but is not prepared at this time to make more definite recommendations." Structural shapes and cast iron used as a reinforcement have to follow the A. S. T. M. specifications.

Mixing and Proportioning

Section V, on "Proportioning and Mixing Concrete," is new and different from anything that has been prepared in official specifications before. Provision is made for alternate measurements either by volume or weight, leaving it to the engineer to decide which one he will use. Three alternate methods are given for the proportioning of the mix. The first establishes the old quantitative mix such as 1:2:4, the exact proportions to be determined by the engineer from concrete tests of the materials to be used. The second specifies that the contractor shall use materials, so proportioned and mixed, as to produce concrete of a required workability and strength. The third specifies that the proportions shall be quantitative, but shall be selected from a table, which is given, similar to the well known Abrams table for proportions of any size of aggregate for certain slump values to give certain strengths.

There is a new paragraph on "Consistency," which requires that the engineer shall determine and specify the consistency of the concrete by the slump test as specified in the American Society for Testing Materials, and a blank table is included giving the maximum slump

for various kinds of concrete, though a footnote gives suggested values for these slumps.

Mixing provisions are not very different from established practice (1½ min. minimum time of mix) except possibly for the phrase "the mixer shall rotate at a peripheral speed of about 200 ft. per minute." Section VI is on "Depositing Concrete," which has nothing radically new, but there is a paragraph on "Compacting which provides for rodding, forcing, tapping or hammering the forms, and a sentence in the "Cold Weather" section which states that "salt, chemicals or other foreign materials shall not be used to prevent freezing." Under the head "Depositing Under Water" there is a footnote which recommends that this not be done unless absolutely necessary, and gives definite instructions as to how it should be placed when necessary. Alternate methods of the tremie, drop-bottom bucket, and bags of concrete are specified. Under the heading "Forms" there is little new matter, and the section VIII, "Details of Construction," which has a subhead "Metal Reinforcement," has little different from old standards, except possibly the paragraph "Exposed reinforcement bars intended for bonding with future extensions shall be protected from corrosion."

Protective Treatments

Under the subhead, "Concrete Covering over Metal," it is stated that metal reinforcement in fire-resistive construction shall be protected by not less than 1 in. of concrete in slabs and walls, and not less than 2 in. in beams, girders and columns, provided aggregate showing an expansion not materially greater than that of limestone or trap rock is used; when impracticable to obtain aggregate of this grade, the protective covering shall be 1 in. thicker and shall be reinforced with metal mesh not exceeding 3 in. in greatest dimensions, placed 1 in. from the finished surface. The metal reinforcement in structures containing incombustible materials and in bridges where the fire hazard is limited, shall be protected by not less than ¾ in. of concrete in slabs and walls and not less than 1½ in. in beams, girders and columns. Plaster finish on an exposed concrete surface may be allowed to reduce the thickness of concrete protection required above by one-half the thickness of the plaster, but the protection shall not be less than that specified above. Paragraphs in the subsection under "Joints" define construction joints in buildings and specify details of water-tight joints.

Under Section IX, "Waterproofing and Protective Treatment," a sentence reads "Integral compounds shall not be used," but membrane waterproofing is specified in "basements, pits, shafts, tunnels, bridge floors, retaining walls and similar structures, where an added protection is desired."

Subheadings "Oilproofing" and "Concrete in Sea Water" are very general. In the former it is stated that "a special coating" shall be applied. In the latter provision is made for a rich concrete; that is, "Plain concrete in sea water or exposed directly along the sea coast shall contain not less than 6 bags of portland cement per cubic yard in place; concrete from 2 ft. below low water to 2 ft. above high water, or from a plane below to a plane above wave action, shall be made of a mixture containing not less than 7 bags. Slag, broken brick, soft limestone, soft sandstone or other porous or weak aggregates shall not be used." It is specified that concrete shall not be deposited under sea water unless unavoidable; that metal reinforcement shall be placed at least 3 in. (4 in. at corners) from any surface. Where unusually severe conditions of abrasion are anticipated, the face of the concrete from 2 ft. below low water to 2 ft. above high water shall be protected by timber, brick, or stone. The final paragraph in this section is that "consistency shall be such as to produce concrete which for mass work shall give a slump of not more than 2 in., and for reinforced concrete a slump of not more than 4 in." Concrete for alkali soils or water shall contain not less than seven bags of portland cement per cubic yard in place, and shall have a slump of not more than 2 in., and for small members of not more than 6 in. Metal reinforcement shall be at least 2 in. from the face.

Section X is on surface finishes and wearing surfaces, and provides for the usual methods of finish, particularly for prevention of premature drying on surfaces that are subjected to wear.

Design Provisions

Section XI is on design. It is apparently a compromise between the provisions of the Joint Committee's final report of 1916 and those of the Building Regulations for Concrete of the American Concrete Institute adopted in 1920, with additions due to later information. For ordinary beams and girders the usual moment formulas are given but there are additional formulas for beams in which exterior columns above and below are built into the beams. The formulas for T-beams are somewhat more elaborate than in either of the preceding reports. There are new provisions regarding the flange width of T-beams and provision for transverse reinforcement where the principal slab reinforcement is parallel to the beams. There is a lengthy section devoted to diagonal tension and shear, which specifies in detail the various methods of reinforcing a beam against shear and the allowable stresses for these different methods. These increase from 2 per cent of the 28-day compression concrete value in the case of beams without web reinforcement with the longitudinal bars not anchored to 12 per cent of the 28-day strength for beams with reinforcement with bars set up in a single plane and with longitudinal bars anchored. The values are given in the table of working stresses herewith.

The provisions for bond are somewhat more specific than in previous reports or specifications. They state that the reinforcement shall be so proportioned that bond stress between metal and concrete shall not exceed 4 per cent of the compression value for plain bars and 5 per cent for deformed bars, and state that in two-way reinforcement the value shall be reduced 25 per cent, and for each additional direction, 10 per cent. For bars anchored at both ends bond stresses may be one and one-half times the value specified.

Flat Slab Design

Flat-slab provisions are about midway between those of the previous final report of the Joint Committee and the Building Regulations of the American Concrete Institute. The coefficient for the numerical sum of the positive and negative moments is given as not less than 0.09. The moments to be used in the design are shown in the accompanying table, but a tolerance of 0.03 M_o is permitted in the sum of the maximum negative moments and of 0.01 M_o in the sum of the maximum negative moments in the two column strips as well as

a tolerance of 0.01 M_o in the middle strip. The total thickness of the dropped panel in inches or of the slab if a dropped panel is not used shall be not less than:

$$t_1 = 0.0382 \left(1 - 1.44 \frac{c}{l}\right) l \sqrt{Rw'} \frac{l_1}{b_1} + 1\tfrac{1}{2}$$

where R = ratio of negative moment in the two column strips to M_o and w' = uniformly distributed dead and live load per unit of area of floor. For slabs with dropped panels the total thickness in inches at points away from the dropped panel shall not be less than $t_2 = 0.02\, l \sqrt{w'} + 1$, and not less than $l/32$ for floor slabs or $l/40$ for roof slabs for either t_1 or t_2, which is identical with the provisions of the 1916 J.C. report and with the general thickness provision in the A.C.I. report. The general point of inflection coefficient is $\frac{3}{16}$ instead of 0.2 in earlier reports. Formulas for figuring tension in the steel and compression in the concrete are given.

MOMENTS TO BE USED IN DESIGN OF FLAT SLABS

Strip	Flat Slabs Without Dropped Panels		Flat Slabs With Dropped Panels	
	Negative	Positive	Negative	Positive
Slabs with 2-way Reinforcement				
Column strip	0.23 M_0	0.11 M_0	0.25 M_0	0.10 M_0
2-Column strips	0.46 M_0	0.22 M_0	0.50 M_0	0.20 M_0
Middle strip	0.16 M_0	0.16 M_0	0.15 M_0	0.15 M_0
Slabs with 2-way Reinforcement				
Column strip	0.25 M_0	0.10 M_0	0.27 M_0	0.095 M_0
2-Column strip	0.50 M_0	0.20 M_0	0.54 M_0	0.190 M_0
Middle strip	0.10 M_0	0.20 M_0	0.08 M_0	0.190 M_0

The shear provisions are that "the shearing unit stress shall not exceed the value of v in the formula,

$$v = 0.02 f'_c (1 + r)$$

nor in any case shall it exceed 0.03 f'_c. In no case shall r (the proportional amount of reinforcement crossing the column capital or over the dropped panel) be less than 0.25."

Columns

The section on columns is considerably more elaborate than either the previous report of the committee or the Building Regulations of the American Concrete Institute. If favors the former in that it continues to give credit for spiral steel by increasing the unit value for the inclosed concrete rather than by actual stress computation for the hooping as was done by the A.C.I. report, but the unit concrete stresses are determined for the spiral columns by a formula which involves the amount of vertical steel and not by direct proportion of the 28-day concrete strength. Length reduction formulas for slender columns, that is where the unsupported length is greater than forty times the least radius of gyration, are given. The principal columns in buildings are required to be not less than 12 in. in width and non-continuous posts not less than 6 in.

The unsupported length of columns for various types of construction is defined. The safe axial load on columns reinforced with longitudinal bars and closely spaced spirals inclosing a circular core are determined by the formula

$$P = A_c f_c + n f_c p A$$

where A = area of the concrete core inclosed within the spiral; P = total safe axial load on column whose h/R is less than 40; p = ratio of effective area of longitudinal reinforcement to area of the concrete core; and $A_c = A(1 - p)$ = net area of concrete core. The allowable value of f_c for use in this type of column is determined for the formula: $f_c = 300 + (0.10 + 4p)\, f'_c$. Longitudinal reinforcement of columns is to consist of at least six bars of minimum diameter of ½ in., and its effective cross-sectional area shall not be less than 1 per cent nor more than 5 per cent of that of the inclosed core.

Spiral reinforcement is not to be less in amount than one-fourth the volume of the longitudinal reinforcement, and consist of evenly spaced continuous spirals held firmly in place and true to line by at least three vertical spacer bars. The spacing of spirals is not to be greater than one-sixth of the diameter of the core and in no case more than 3 in. Reinforcement is protected everywhere by a covering of concrete cast monolithic with the core, which shall have a minimum thickness of 1½ in. in square columns and 2 in. in round or octagonal columns.

For columns reinforced with longitudinal bars and separate lateral ties the value for f_c shall not exceed 0.20 f'_c. The amount of longitudinal reinforcement considered in the calculation shall not be more than 2 per cent nor less than 0.5 per cent of the total area of the column. The longitudinal reinforcement shall consist of not less than 4 bars of minimum diameter of ½ in., placed with clear distance from the face of the column not less than 2 in., and lateral ties are not to be less than ¼ in. in diameter, spaced not farther apart than 8 in.

Special paragraphs follow on columns subjected to bending stresses and on composite columns, being practically the same as those in the A.C.I. report.

Footings

Footings are taken up much more elaborately than in any previous specifications. It is stated that the requirements for flexure and shear in the rest of the specifications shall govern the design of footings, except as provided otherwise; that the upward reaction per unit of area on the footing shall be taken as the column load divided by the area of the base; that footings carried on piles are to be treated in the same manner as those bearing directly on the soil, except that the reaction is to be considered as a series of concentrated loads applied at the pile centers. Sloped footings and stepped footings are defined, and the critical section for bending stated to be at the face of the column or pedestal. Where a concrete pedestal is used and where steel or cast-iron bases are used, the moment in the footing is to be calculated at the edge of the base and at the center. Formulas are given for square columns on square footings, and round columns on square footings.

Reinforcement necesary to resist bending moment is to be determined as for a reinforced-concrete beam; the effective depth of the footing shall be the depth from the top to the plane of reinforcement. Required area of reinforcement thus calculated is to be spaced uniformly across the footing, unless the footing width is greater than the side of the column or pedestal plus twice the effective depth of the footing, in which case the width over which the reinforcement is spread may be increased to include one-half the remaining width of the footing. Extreme fiber stress is to be kept within the limits shown in the table at the end of this abstract. Shearing and bond stresses are to be cared for as in other structures. Methods of distributing stress from the columns to the footings are noted and a formula is given for the permissible compressive unit stress under the column core.

The succeeding section is on "Reinforced-Concrete Retaining Walls." The sections on "Floor Slabs Sup-

ported on Four Sides" and on "Shrinkage and Temperature Stresses" the committee is not ready to report on.

A final section is "Summary of Working Stresses," which details the coefficients of the 28-day compressive strength used for each of the different kinds of stresses under different conditions. The comprehensive value f_c is defined as "the ultimate compressive strength of concrete at age of 28 days, based on tests of 6 x 12-in. or 8 x 16-in. cylinders made and tested in accordance with standard methods of making and storing specimens of concrete in the field and the tentative methods of making compression tests of concrete," both standards of the American Society for Testing Materials. The values of the working stresses are tabulated as follows:

MAXIMUM DIRECT STRESSES IN CONCRETE

Direct Compression.
- (*a*) Columns whose length does not exceed 40 *R*:
  - (1) With spirals.....varies with amount of longitudinal reinforcement
  - (2) Without spirals .....0.20 f'_c
- (*b*) Long columns .....(by formula)
- (*c*) Piers and Pedestals:
  - (1) Without reinforcement .....0.25 f'_c

Compression in Extreme Fiber.
- (*a*) Extreme fiber stress in flexure.....0.40 f'_c
- (*b*) Extreme fiber stress adjacent to supports of continuous beams .....0.45 f'_c

Bearing Compression.
- Anchorage of reinforcement.....0.50 f'_c

Tension.
- All concrete members.....none

MAXIMUM SHEARING STRESSES IN CONCRETE

Beams without Web Reinforcement.
- (*a*) Longitudinal bars anchored.....0.03 f'_c
- (*b*) Longitudinal bars not anchored.....0.02 f'_c

Beams with Reinforcement.
- (*a*) Beams with stirrups.....special
- (*b*) Beams with bars bent up in several planes....special
- (*c*) Beams with bars bent up in a single plane:
  - (1) Longitudinal bars anchored.....0.12 f'_c
  - (2) Longitudinal bars not anchored.....0.06 f'_c

Flat Slabs.
- (*a*) Shear at distance *d* from capital or dropped panel .....0.03 f'_c

Footings.
- (*a*) Longitudinal bars anchored.....0.03 f'_c
- (*b*) Longitudinal bars not anchored.....0.02 f'_c

MAXIMUM STRESSES IN REINFORCEMENT

Tension in Steel.
- (*a*) Billet-steel bars:
  - (1) Structural steel grade.....16,000 lb. per sq.in.
  - (2) Intermediate grade .....18,000 " "
  - (3) Hard grade .....18,000 " "
- (*b*) Rail-steel bars .....16,000 " "
- (*c*) Structural steel .....16,000 " "
- (*d*) Cold-drawn steel wire:
  - (1) Spirals.....stress not calculated
  - (2) Elsewhere.....18,000 lb. per sq.in.

Compression in Steel.
- (*a*) Bars.....same as above
- (*b*) Structural steel core of composite column..18,000 lb. per sq.in., reduced for slenderness ratio
- (*c*) Structural steel column.....16,000 lb. per sq.in., reduced for slenderness ratio

Compression in Cast Iron.
- Composite columns with spirals.....10,000 lb. per sq.in.

MAXIMUM BOND BETWEEN CONCRETE AND STEEL

Bond.
- (*a*) Beams and slabs, plain bars.....0.04 f'_c
- (*b*) Beams and slabs, deformed bars.....0.05 f'_c
- (*c*) Footings, plain bars, one-way.....0.04 f'_c
- (*d*) Footings, deformed bars, one-way.....0.05 f'_c
- (*e*) Footings, two-way reinforcement.....(*c*) or (*d*) reduced by 25 per cent
- (*f*) Footings, each additional direction of reinforcement.....(*c*) or (*d*) reduced by 10 per cent

The personnel of the Joint Committee is at present:

American Society of Civil Engineers.—W. A. Slater, chairman; William K. Hatt, A. E. Lindau, Sanford E. Thompson, Franklin R. McMillan.

American Society for Testing Materials.—Richard L. Humphrey, chairman; Albert T. Goldbeck, Edward E. Hughes, Henry H. Quimby, Leon S. Moisseiff.

American Railway Engineering Association.—J. J. Yates, chairman; George E. Boyd, Frederick E. Schall, H. T. Welty, C. C. Westfall.

American Concrete Institute.—S. C. Hollister, chairman; Robert W. Lesley, Arthur R. Lord, Egbert J. Moore, Angus B. MacMillan.

Portland Cement Association.—Frederick W. Kelley, chairman; Duff A. Abrams, Ernest Ashton, Edward D. Boyer, J. E. Freeman.

Richard L. Humphrey is chairman, J. J. Yates, vice-chairman and Prof. Duff A. Abrams, secretary.

Airplane Saved Large Sum in Railroad Reconnaissance Survey

PREDICTION that investigation by airplane will in a short time precede all railroad surveys through unknown country is made in a letter furnished to the *Engineering News-Record* by the Chief of the Air Service, United States Army, written by E. S. Piontkowski, chief engineer, Manila Railroad Co., who made the flight with members of the Third Aero Squadron, Camp Stotsenburg, Philippine Islands, which enabled him to determine which one of three general routes would be used for a new line. The flight was briefly noted in *Engineering News-Record*, Sept. 23, 1920, p. 593. The new line was projected by the Manila Railroad Co. as an extension of its line from Cabanatuan through parts of the provinces of Nueva Ecija and Nueva Vizcaya to Bayombong.

Mr. Piontkowski's letter, transmitted to the Chief of the Air Service of the Army, is in part as follows:

The flight was in the nature of a trial trip as I had never been up in the air before and had no idea whether any information of real value could be obtained or not. The trip was a revelation to me and I cannot understand why airplanes were never used before in reconnaissance surveys, for as much can be accomplished in one day with a plane as would take months of time and thousands of dollars to do by instrument surveys. The flight was taken at the beginning of the rainy season and shortly after our arrival at the pass the clouds came down and covered the summit rendering it impossible to obtain any idea of the other side of the range and the outlets thereto. However, I secured enough information on this side to demonstrate how much could be done by flights in the dry season. As it was, I can now eliminate two lines on this side that the engineers on survey would necessarily have had to try, and which would have taken many months and great expense.

One definite benefit gained from this flight is shown: A line was decided upon, after instrument reconnaissance, as being the best for the final location, but after information gained in this flight was sent to the locating engineer, the line was changed and a much better location will be had both as to cost of construction and alignment.

There is no question but that in mountainous and heavily timbered country, of which no accurate maps exist, the saving that could be effected by several flights over proposed lines would be enormous, and I anticipate in a short time all railroad surveys through unknown country will be preceded by airplane investigation.

Elimination of Tastes in Water at Marquette, Michigan

By W. C. Brockway
Assistant State Sanitary Engineer,
Michigan Department of Health

ONLY one or possibly two of the many waste products from the manufacture of wood alcohol at Marquette, Mich., were found to be responsible for the offensive tastes and odors which have existed for a number of years in the municipal water supply. H. B. Hommon, associate sanitary engineer, United States Public Health Service, assisted by an engineer from the Michigan Department of Health conducted an investigation last March to determine the cause of these tastes and odors and to devise some method whereby they could be eliminated. The tastes were similar to those caused by excess chlorine and for this reason many of the water consumers believed the trouble to be due to the chlorine treatment of the city supply. There have been complaints of tastes in the water ever since the manufacture of wood alcohol was started in 1901, which was long before the hypochlorite plant was installed in 1910. Tastes are more persistent than the odors and are therefore much more objectionable. The company making

MAP OF CITY OF MARQUETTE AND ADJACENT WATER

wood alcohol has decided to try evaporating the most troublesome waste to 25 per cent of its volume and use the residue as liquid fuel.

The Marquette water supply (see map) is taken from Lake Superior, 3,000 ft. from shore, through a 30-in. steel intake pipe with three terminal inlets 12 ft. above lake bottom in about 65 ft. of water. Southwest of the intake there is a government breakwater about 4,500 ft. long. Seven outfall sewers discharge city sewage into Lake Superior west of the breakwater, on the side opposite the intake, so the breakwater acts as a huge baffle to keep sewage contamination from the intake. About two miles north of the intake wood alcohol wastes from the Cleveland-Cliffs Iron Co. are emptied into the lake. A small sanitary sewer also empties into the lake near this point.

The process of manufacturing wood alcohol consists of the destructive distillation of hardwood and the subsequent refining of the products. The distillate is called pyroligneous acid and contains the following ingredients: Methyl alcohol, acetone, methyl acetate, acetic acid, tar and small amounts of many other kinds of by-products. Pyroligneous acid is allowed to settle until all the tar capable of settling has been deposited in the bottom of tanks. This tar goes to the tar plant and is separated into pitch and cresote oils. The supernatant liquid is passed through triple effect evaporators so that practically all the remaining tar is left behind. This residue is wasted and is the product causing tastes in the city water supply. The distillate from the supernatant liquor is neutralized with lime and then distilled. The residue, acetate of lime in solution, is evaporated to dryness. The distillate, which contains the crude alcohol, is passed to the crude alcohol still where the very small amount of residual tar is removed with other by-products. This waste is next in importance to the tar wastes mentioned above. Discontinuous stills are used to remove various impurities from the distillates. Most of the wastes from these stills are of no particular importance as far as taste producting qualities are concerned.

The attitude of the company at first was: (1) That everything possible to eliminate objectionable wastes had been done by their own men and that there was nothing left to accomplish. (2) That evaporation, especially, was impossible because of the enormous cost. The assumption was that all of the chemical wastes would have to be evaporated. (3) That the chlorine used to treat the city water and not their chemical wastes was the cause of the tastes.

Results of Tests for Chlorine

Excess chlorine was not the cause of the taste, as was demonstrated by about seventy qualitative starch-iodide tests for excess chlorine taken every hour day and night for two days at the three hospitals and at the city health office. All tests for chlorine were negative but tastes were frequently detected. At the pumping station, however, where the chlorine is added, the tests showed an excess.

Since the maximum variation of pumpage was less than 20 per cent from the average it was not considered necessary to adjust the chlorine dose for this difference. Experience showed that about 0.5 p.p.m. excess chlorine can be detected by taste in the Marquette water. A positive reaction with starch-iodide is obtained with an excess of only 0.05 p.p.m., one-tenth as much.

The compounds causing tastes are harmless in themselves but may affect health indirectly through the imagination. Women, children and persons with ill health complained very seriously about the water. There were great differences of opinion among the people as to the extent or degree of tastes. In any case, however, the condition was serious and demanded a remedy. Many stated that they drank as little water as they could get along with—which is not sufficient to meet the natural demands of the human system—or used water from wells and springs that in a number of cases did not furnish a water that compared favorably with the Treasury Department Standard.

Examinations of the individual waste products as discharged from the stills and other refining processes showed that there are three classes relative to taste producing qualities:

1. Tarry wastes are by far the most important. These gave the characteristic tastes found in the city water in direct dilutions of 1 c.c. in 1,300,000 c.c. of water. Experiments were also carried out in which fresh supplies of water in 2,000 c.c. quantities were added at several different times in the course of a week to 1 c.c. of the more insoluble tars. The taste would persist to the last change but became less perceptible each time. One experiment similar to these, in which the water was changed seven times in the course of a month, demonstrated that a very positive taste was still present at the

end of that time. The same result was obtained under like circumstances when a very small piece of tar deposit found along the beach was used. This waste is black in color, has a strong pungent odor of tar or creosote and is slightly viscous and dissolves very slowly in water. Relative to specific gravity there are three groups; one has a specific gravity equal to that of water; a second less and a third greater than that of water. These wastes, including the portions dissolved, are fixed, permanent and stable compounds not undergoing changes like sewage. The wastes amount to about 6,000 gal. They are probably responsible for practically the entire nuisance.

2. The waste next in importance is from the crude alcohol still. This contains a very small portion of tar but consists mainly of light oils. It is bright yellow in color, has a fairly strong tar odor and a brackish or bitter taste which can be detected in a direct dilution of about 1 in 2,000 and is probably not responsible for very much, if any, of the taste in the city water. The approximate discharge is about 6,000 gal. a day.

3. The remainder of the chemical wastes cause little or no tastes in dilutions up to 1 in 2,000.

The outfall from the plant discharges about 3 m.g.d., which includes surface drainage, cooling water, and about 50,000 to 60,000 gal. of chemical wastes. Each of the two most objectionable consist of about 6,000 gal. a day. The wastes affect the water supply particularly when there is a north or northwest wind which drives the wastes southward along the shore from the outfall to the vicinity of the city intake. Tastes disappear when south winds blow.

Removing Tar Wastes

Previous investigations, all of which contributed valuable information, have been made by the following men: Prof. George A. Koenig, G. H. Benzenberg, Clarence Coleman, Dr. McCracken, Rudolph Hering and George A. Johnson. These investigators concluded that tastes were due to the tar wastes and that enormous dilutions provided the most satisfactory way of overcoming the tastes and odors. The intake was extended in 1911-12 from 700 to 3,100 ft. to its present location to afford this dilution and to offset the danger from sewage contamination. The breakwater was extended to its present location at about that time.

One investigator was very confident that filtration would remove the objectionable tar wastes. He said that "filtration is quick and perfect by mixing charcoal braise with the discharge and then throwing the whole upon a sand filter. The charcoal will attract the tiniest particles of tar and the tar and charcoal can then be used as fuel." Operation of this filter proved it to be a failure so after two years its use was abandoned. From the meagre information to be had concerning this filter, it appears that it was greatly overloaded.

The company decided entirely upon its own initiative at the time of the investigation that evaporation of the most objectionable of the wastes would be the best solution of the problem. Tar wastes are to be evaporated to 25 per cent of their original volume so that they can be used as liquid fuel. If the treatment of these wastes does not abate the nuisance evaporation of the second most objectionable waste will be started. The cost to do this, of course, is much greater than the value of the fuel produced. Since the tar wastes are discharged not much less fuel is required than otherwise. Acids must be distilled off in order to protect the boiler flues. Orders were placed in March for the necessary evaporators.

The situation in general hinged on the following: (1) The company had previously spent money on methods that were thought to be adequate to overcome the nuisance but in each case the process proved to be a failure. This made the company cautious and doubtful about other untried methods or schemes. (2) The corporation producing wastes was held to be entirely responsible for preventing them from causing a nuisance. (3) Efforts of all concerned were co-ordinated. (4) Even though the company was confident everything possible had been done to eliminate offensive tastes, yet it was found that something very practical had not been attempted. (5) The federal and state engineers were to remain at Marquette until the company had taken a definite step to abate the trouble by either retaining an expert sanitary engineer to study the problem or by ordering the necessary apparatus for treating the wastes.

After a few days of investigation it was evident that the removal of the trouble at its source was the only practical solution. Prevention is not only better than a cure but in this case prevention seemed to be the only practical possibility.

Evaporation of objectionable wastes as a method of disposal cannot fail to eliminate the nuisance if it is due entirely to freshly discharged chemical refuse. Offensive wastes, however, have been discharged into Lake Superior since 1901. As a result quantities of tar have been deposited. Tastes from such deposits may be so persistent and penetrating that they may be present in the city water supply for a long time to come though no more wastes are discharged into the lake.

Dressings for Tar Macadam Roads

Many British motorists are complaining of the material used by the highway authorities for the surface dressing of macadam roads, especially of the coarseness of the material for gritting newly laid tar. Mr. Dryland, county surveyor of Middlesex, condemns the use of a large size aggregate as not only being harmful to motor tires but unsuitable for a tar-macadamized or other smooth surfaced road, though such an aggregate may be used with advantage on a rough surface. In a letter to the *Municipal Engineering and Sanitary Record*, Mr. Dryland says:

"Where traffic is light and the situation open, a coating of tar on a waterbound road, followed by a good dressing of coarse chippings, undoubtedly forms a thin carpet which has considerable durability as a wearing surface, but on heavily trafficked roads, especially if on a clay subsoil where damp hangs in the autumn and winter, such treatment is unsatisfactory, as it results in a pasty mud.

"Fine material, owing to its greater covering power, is, of course, much cheaper, and I am inclined to the view, after extensive opportunities for observation over larger areas for a number of years, that large aggregate is often used where smaller would be more beneficial and also cheaper."

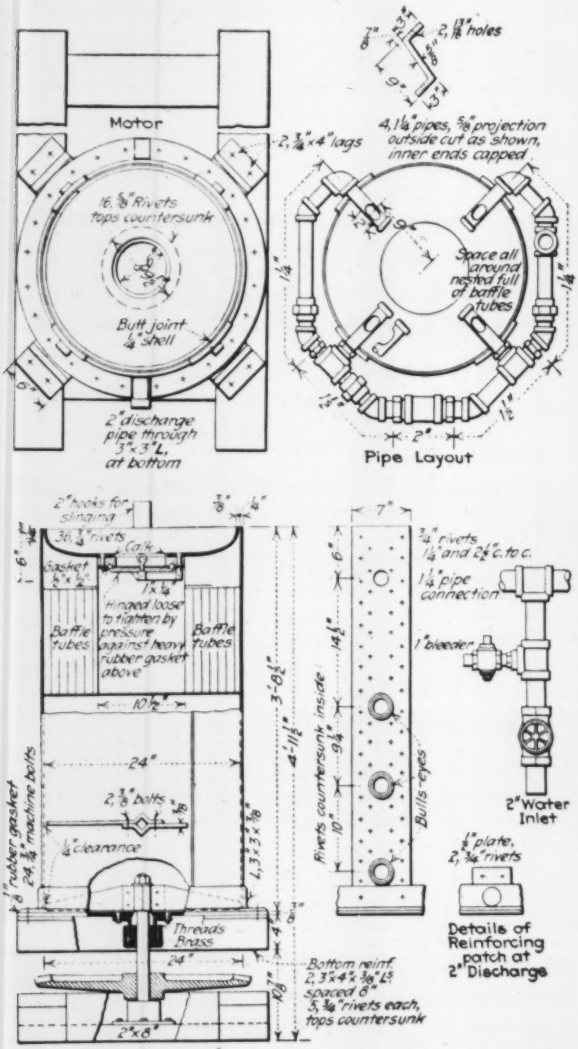
The County Surveyor of Kent, on the other hand, condemns the use of any aggregate smaller than ¼ in. to ½ in. gage. Clean chippings and grit of these sizes, though damaging to tires for a short period when newly laid, subsequently form a far more enduring and efficient surface.

Experiences in Pressure Grouting Lead to Hydraulic Machine

New Type Designed as Result of Several Large Grouting Jobs Is Used in Consolidating Foundations of Two Dams

By Shirley C. Hulse
Engineer, Bedford, Pa.

GROUTING, when properly done, is a process of sedimentation. A flow of grout resulting in the desired deposit of cement and expulsion of excess water is best accomplished by an inelastic driving medium. This is especially true where, as in rock foundations, there may be a great range and complication of crevices and surface leaks. It is easy indeed to squirt grout into a hole till no more will go in; it is a different matter to feel, when a hole refuses, that the last bit


Motor
16, ⅞" Rivets tops countersunk
Butt joint ¼" shell
2" discharge pipe through 5"×3" L, at bottom
2, ⅞" holes
4, 1¼" pipes, ⅝" projection outside cut as shown, inner ends capped
2, ¾"×4" lags
Space all around nested full of baffle tubes
Pipe Layout
2" hooks for slinging
36, ¾" rivets
Gasket ½"×½"
Hinged loose to tighten by pressure against heavy rubber gasket above
Baffle tubes
Baffle tubes
24"
2, ⅞" bolts
½" clearance
Threads Brass
Bottom reinf. 2, 3"×4"×⅜" L's spaced 6" 5, ⅞" rivets each, tops countersunk
2"×8"
Rivets countersunk inside
Bull's-eyes
¾" rivets 1¼" and 2½" c. to c.
1¼" pipe connection
1" bleeder
2" Water Inlet
⅛" plate, 2, ¾" rivets
Details of Reinforcing patch at 2" Discharge

DETAILS OF THE HULSE HYDRAULIC GROUTING MACHINE

of cement which it could possibly have been made to take has been got into that hole. Ordinarily, the immediate proof of the success of a grouting operation is limited to the behavior of test holes or to the evidence disclosed by subsequent excavation. Results are dependent upon the experience, skill and imagination of the operator and there is plenty of scope for his talents without the added complication of an elastic treacherous driving medium behind the grout.

Since 1910 the writer has had almost continuously to do with pressure grouting; some of it experimental and most of it in connection with large structures where it played a vital part in their integrity. Early in this experience he became convinced that if water pressure could be directly used to expel the grout from the machine it would be infinitely preferable to compressed air and, after considerable experiment, he worked out a machine which accomplished the desired result. This machine has been patented and is being marketed but as it includes a number of novel features and the basis of its design is different from previous grouting devices, a description of its details and of its operation should have engineering interest.

Design of the Machine

The considerations governing the design of the machine are as follows: (1) Mechanical mixing of the grout is essential. (2) Water pressure is inelastic and instantly controlled. It obviates entrained air and blowouts. (3) Compressed air is very useful for developing surface leaks and for cleaning openings before grouting but it is not a satisfactory driving medium because of its elasticity. (4) One hundred pounds pressure is frequently inadequate in grouting operations and higher pressures are to be had, on most work, more readily and cheaply in water than in air. (5) Almost invariably water pressure proves to be more dependable than air pressure and less liable to interruption.

The machine shown in the drawing herewith consists of a vertical cylinder with a small two-bladed paddle, motor driven, in the bottom. The cement is introduced through a self-sealing door in the center of the top and through the 10½-in. cylindrical opening into the water. The space between the outside of this cylinder and the main shell is filled with vertical tubes about 1 in. in diameter and 9 in. long, snugly nested together and forming a sort of honeycomb as viewed from above or below. The sole purpose of these tubes is to bring the water, used for expelling the grout, into contact with the upper surface of the grout in a smooth plane without cross currents or disturbance. Above the tops of the baffle tubes are four inlet pipes whose openings are such that the water cannot leave them at any angle below the horizontal. The combined action of the inlets and the tubes is such that there is no tendency of the water, during the expulsion of the grout, to dilute or mix with the grout until the plane of contact is near the top of the paddles when it is time to shoot off and reload. If discharge be continued, after the plane of contact has been broken by the paddles, the breakup will promptly diffuse the remaining cement through the overlying water to the bottom of the baffle tubes. This action and the descending clean-cut line of demarcation between the water and the grout are clearly visible during operation, through the glass bull's-eyes in the side of the machine and these bull's-eyes give a certainty of control and an exact knowledge of the time to shut off and recharge that I have not found in any other grouting device.

The water below the baffle tubes is carried at about the speed of the paddles, 20 to 25 r.p.m., and the cement upon dropping into the water becomes instantly diffused

and is carried in suspension. When the clear water comes from above and forces the grout through the outlet at the bottom of the machine there is no tendency for the two liquids (grout and water) to mix until the line of separation is so close as to feel the mechanical disturbance of the paddles. The sole purpose of the baffle tubes is to straighten out the water which expels the grout. No cement goes through the tubes except what little enters them incidentally from below.

It is necessary to bleed the machine, after discharge, to make room for the next charge of cement. This may be done by putting the bleeder in the inlet line, letting the water overflow through the baffle tubes and the inlets as the cement is introduced. In fast work it is better to replace the top bull's-eye with a nipple and stopcock from which a piece of hose reaches the ground. The siphon action of this bleeder makes it very quick and with its use the action of the machine may be almost continuous and very much faster than that of an air machine where time is lost, after each discharge, in refilling with water. The amount of cement wasted in bleeding is so slight as to be negligible.

While primarily designed for water pressure this machine may be operated with air.

Three machines have been built and operated. The first was used on the foundations of the Alcoa Dam of the Aluminum Co. of America, at Alcoa, Tenn. The writer had direct charge of the grouting of these foundations for several months during the early part of which, and while the hydraulic pressure machine was being built, an air machine was in use. The work differed in no essential from a number of similar grouting jobs. There were the usual unavoidable interruptions due to low air pressure or to no air pressure which meant merely interruption to the rest of the work but which meant the difference between continuous good grouting and intermittent questionable grouting. On work of this magnitude the only safeguard is a tank of water always available at such pressure that a hole may be thoroughly washed out if the pressure fails for long enough to endanger the hole. It is a fact, sometimes easily to be accounted for, that a hole in which the work has been too long interrupted before refusal, will be closed upon resumption and must be abandoned with the certainty that territory connecting with that hole is not filled. It is also a fact that frequently a hole may be uninterruptedly grouted to refusal on two or three successive days, before final refusal and the certainty that every opening within its reach has been closed. During this part of the work there were also the unavoidable troubles due to entrained air with an occasional spectacular blowout through surface leaks.

It must not be inferred from the foregoing that the final results had with the air machine were not dependable. They were made dependable at the cost of wasted time and cement inherent in use of compressed air for this sort of work. We had an exceptionally competent foreman, a first-class crew and every facility and assistance at the command of I. G. Calderwood, general superintendent, was afforded the grouting work at all times. What troubles we had were due to compressed air—or to its lack—nothing else.

The latter part of the work at Alcoa was done with the hydraulic pressure machine and it more than filled expectations. Water pressure was much more dependable than air had been (as is usually the case) and interruptions were so few as to be almost negligible. Entrained air and blowouts were a thing of the past and in a short time one could turn one's back on the man at the valves without instinctively fearing a shower of grout from some surface leak. The discharge was under absolute control and the holes were much more rapidly and satisfactorily closed. This rapidity and certainty of action is a source of extra satisfaction when the grouting is barely keeping ahead of the concrete or other work.

The second and third machines were built for the Junction Dam in Michigan, Fargo Engineering Co. of Jackson, Mich., engineers, which work has been described in *Engineering News-Record*, July 18, 1918, p. 147. The writer did not visit this work until the grouting operations were well under way and he found upon arrival that it was desired to grout a cutoff in a stratum of sand underlying the hardpan upon which the dam rested. Grout will not penetrate sand because the resistance of the small passages is such that the grout is instantly slowed down to the point where the cement will not be carried in suspension and the sand plugs *immediately* where the grout started to enter. This particular sand was fine grained, it bore water under considerable artesian pressure and the temperature of the stratum was so low that grout which had been forced down the pipes remained liquid and flowed back to the surface several days after grouting. It

HYDRAULIC GROUTING MACHINE AT WORK ON JUNCTION DAM IN MICHIGAN

was decided to space the grout pipes rather closely along the line where the cutoff was wanted; to wash a channel from pipe to pipe in the sand beneath the hardpan; to fill this channel with grout and after the grout had set to drill through it and repeat the operation—thus forming successive layers downward.

Both water and air pressure were available on this work but it soon developed that lack of positive control and the action of entrained air worked against the desired result and a centrifugal pump developing 200 lb. pressure was installed especially for the grouting operations. From this time on the air was used merely to develop the few surface leaks, to test out the tightness of the work and occasionally in advance of the first batch of grout with the idea of perhaps forcing back the artesian water. The efficacy of this latter procedure is quite open to question. Water pressure did the grouting.

A steam line was run to the grouting machines and the grout was used hot. Under these conditions it was possible to drill through each day's grouting on the following morning. The drill washings and the chunks of solid material which came up from below were most illuminating. They showed that the grout penetrated and packed crevices in the hardpan, some of considerable thickness and others merely hair cracks. There was no evidence that loose sand had been penetrated and consolidated by the grout. The excess water, after the cement was deposited, was of course shoved back through whatever channels the artesian water reached the grout holes (the grouting pressure being far in excess of the artesian) and this made an ideal condition for the sedimentary action by which the cement was deposited.

The general efficacy of the work was shown by the fact that grout was driven out through every surface leak which had been developed by 100 lb. of air. A few of these leaks were at a considerable distance from the line of the cutoff and there is slight probability that all would have been closed by air driven grout. Sand was used in much of the grout on this work at a considerable saving of cement and the machine handled it as well as it did the all-cement mixtures.

Earth Road Maintenance Costs in Nebraska

MAINTENANCE costs on about 1,100 miles of earth roads in 20 counties in southeastern Nebraska in 1920 are summarized in the accompanying table. These costs do not include purchase or depreciation of equipment, patrol stations nor heavy gang work. The costs are listed separately for the three types of patrol employed.

Item	Team	Truck	Tractor
Surface	$146.37	$122.46	$132.56
Shoulders	9.30	7.05	8.35
Ditches	21.95	10.29	15.86
Culverts	12.85	7.53	10.34
Brush	16.69	6.86	6.55
Mowing	15.46	6.12	5.02
Snow	10.19	5.00	9.96
Guard rail	0.63	1.74	0.52
Markers	1.50	2.58	2.31
Bridges	5.91	4.45	1.81
Equipment	4.10	19.65	24.87
Claims	25.61	49.61	36.88
Materials	4.59	7.15	0.79
Shops	.....	3.74	.....
Mileage patrolled	455.56	514.58	137.33
Per mile per season	275.09	254.22	255.83
Per mile per month	34.63	28.25	30.11
Average mileage in patrol	6.33	13.91	15.26
Number patrols	72	37	9

British Labor Railroad Bill—Progress in Consolidations

(London Correspondence)

A BILL to effect the transfer of all the railway undertakings in England to the Ministry of Transport is to be introduced into Parliament by the Labor party. The bill makes provision for the purchase by the State of all the railway undertakings in Great Britain and for their subsequent management in the public interest by the Minister of Transport.

Clauses in the bill provide that:

1. Six months after the passing of the act all the property of the railway companies and the Railway Clearing House shall vest in the Minister without any formal conveyance being necessary.

2. The purchase shall be carried through by the issue to the railway stock and share holders direct (and not through the intervention of the companies), on the surrender for cancellation of the railway stock and share certificates which they hold, of a specially created railway stock charged on the State railway undertaking and the Consolidated Fund, which shall bear such a rate of interest as would enable it at the time of issue to be realized at par. The purchase price would be calculated on the basis of the pre-war market price of the existing railway stocks, but be subject to a reduction relative to the amount by which securities generally have depreciated in value in consequence of the war.

3. The reduction in view of the general depreciation of the value of securities should be made at the rate of 30 per cent.

4. The Minister be formally authorized to carry on and develop the railway business, to acquire land for the purposes of development and extensions, and to be provided by the Treasury with any advances which may be necessary during the transition period.

5. The general direction of the railway business be devolved upon seven commissioners, whilst the Minister will be responsible to Parliament. It is intended that of the first commissioners the chairman and two others shall be appointed by the Minister, one by the Treasury, and three by the Minister on nominations submitted by the recognized railway trade unions, and that any vacancies shall be filled in like manner, as to six by the Minister and one by the Treasury. It is provided that the commissioners shall devote their whole time to the duties of their office; shall each be paid the same salary, and shall have continuity of office subject to removal by the Crown.

6. The Minister be authorized to acquire privately owned railway stock.

7. The Minister shall set up, in conjunction with the three railway trade unions, machinery for adjusting disputes as to salaries, wages and conditions of the service.

8. The existing State control and financial guarantee of the railways shall be continued until the appointed day.

An important step toward the grouping of English railways into a limited number of large systems is the recent amalgamation of the London & Northwestern Ry. and the Lancashire & Yorkshire Ry. into a system of 2,667 miles, the former being one of the largest

individual lines and the latter serving a large industrial district. The step has been taken by private agreement and requires only formal ratification by the stockholders. The government project for consolidating the railways into a few systems grouped geographically, as approved in principle but not in detail by the railway companies, was noted in *Engineering News-Record* of Feb. 24, p. 341.

Both railways have electrified suburban lines, and both of them own and operate docks, canals, hotels, and steamship lines (to Irish and North Sea ports). A summary of their capital and 1920 traffic is as follows:

	L. & N.W. Ry.	L. & Y. Ry
Passengers	113,873,294	92,407,792
Freight, tons	33,730,516	14,744,422
Train-miles	41,027,566	16,238,954
Capital, at normal exchange	$639,426,485	$361,159,650

The London & Northwestern Ry. extends diagonally from London to Birmingham and Liverpool (198 miles) and north to Carlile (300 miles), with numerous lines through the central industrial section and into Wales. It owns 1,806 miles of line and leases or operates 260, making a total of 2,066 miles, of which 1,577 miles are double track and a considerable proportion has three or more tracks, the total trackage being 5,824 miles, including sidings. Its main tracks are laid with 95-lb. bull-head rails in 60-ft. lengths. The equipment comprises 3,261 locomotives, 9,550 cars in passenger service and 84,000 in freight and company service, besides gasoline and electric rail motor cars.

The Lancashire & Yorkshire Ry. extends between the west port of Liverpool and the east ports of Goole and Hull, with a network of lines in the coal and manufacturing districts traversed. It owns 533 miles and operates a total of 601 miles, of which 557 miles are double track, the total trackage being 2,270 miles inclusive of sidings. There are 1,650 locomotives, 4,360 cars in passenger service and 37,780 in freight and company service.

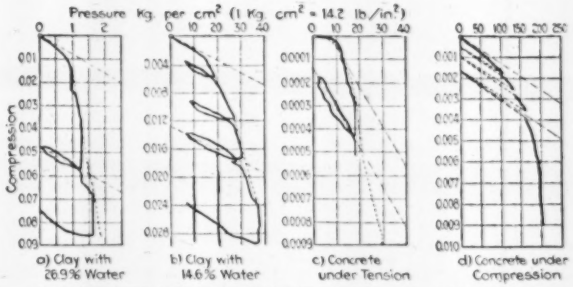
LETTERS TO THE EDITOR

If you have ideas that would interest engineers and contractors we shall be glad to give them space here. We urge, however, that you be brief so that a wide range of subjects may be covered in the available space.—The Editor.

Foundation Problems and Laboratory Research

Sir—In his paper "Distribution of Soil Pressure as Related to Foundations," *Engineering News-Record* Mar. 3, 1921, p. 366, Daniel E. Moran arrives at the conclusion that a surcharge equal to half the diameter of a circular footing would be sufficient to prevent a "stress producing uplift of the sand." Thorough experimental investigations concerning this point were carried out by Strohschneider in 1911 ("Elastische Druckverteilung und Drucküberschreitung in Schüttungen," Sitz. d. kais. Akad. d. Wiss., Math. nat. Klasse, Feb., 1912), but no conclusions similar to those of Mr. Moran could be drawn from the results. The same author published, in the paper mentioned, the soil-pressure curves (Fig. 3 in Mr. Moran's paper) obtained by a very sensitive apparatus for measuring the vertical pressure, and he modified Boussinesq's formula so as to describe almost perfectly the observed phenomena.

The lateral escape of the sand due to the presence of a concentrated load was theoretically investigated by Pauker, Jankowsky and Kjurdümoff. Kjurdümoff published in addition photographs showing the movement of the sand grains which is produced by the application of a single load on the horizontal surface of a bed of sand (*Der Zivilingenieur*, St. Petersburg, 1891.) Engesser ("Zur Theorie des Baugrundes," Zentrbl. d. Bauverw, 1893) discussed the phenomena of unequal settlement of a homogenous soil and furnished an approximative theory of the unequal distribution of the soil pressure over the bearing surface of foundation girders which support concentrated loads.


Pressure Kg. per cm² (1 Kg. cm² = 14.2 lb./in²)
Compression
a) Clay with 26.9% Water
b) Clay with 14.6% Water
c) Concrete under Tension
d) Concrete under Compression

STRESS-STRAIN CURVES OF CLAY AND CONCRETE

Under the impression of these investigations I undertook in 1911 to design the foundation of a five-story reinforced-concrete building covering an area of about 25,000 sq.ft. of bad ground, on the assumption that the soil pressures are at a maximum immediately underneath the columns and that their intensity decreases with the distance therefrom. The foundation consisted of a continuous slab reinforced by a grillage of heavy reinforced-concrete beams. The empirical coefficients required for the computation of the distribution of the pressures were obtained by loading tests made on a rather large scale within the foundation pit. As the method proved to be a complete success in spite of the serious objections made by the local building department, it was accepted for the design of a number of other foundations. The idea that the assumption of uniform stress-distribution in the material underlying the footing would be untenable has therefore already quite a historical record.

The essential facts required for the purpose of properly designing a foundation as mentioned above are the stress-strain relations for the soil in question. My investigations concerning these facts have led to the result that the stress-strain diagrams of sand, clays in any state of dryness or humidity and of concrete are almost identical provided the scale for plotting stress and strain are properly chosen. The group of diagrams herewith shows the similarity; the close relationship between them and the interesting diagrams published in Fig. 3 of Lazarus White's paper ("Earth in Foundations Considered as an Elastic Solid," *Engineering News-Record*, Dec. 30, 1920) is obvious. The modulus of elasticity of sand increases in direct proportion with the depth below the surface. The modulus of elasticity of clays stands in a definite relation to their water content, which in turn is again a function of the pressure (capillary or external pressure.) The diagrams demonstrate that the stress-strain relations in earth masses exist not merely by highly artificial mechanisms as George Paaswell says in his paper "Effect of Practical Factors on Earth-pressure Theory," *Engineering News-Record*, Apr. 21, 1921, p. 682, but that they are in every detail comparable with those of solid granular bodies. The intimate relationship includes even elastic after-effect and hysteresis. The diagrams show, furthermore, that one cannot possibly speak of a definite ratio between total and elastic compression (Moran, in his paper mentioned above, p. 369), because this ratio increases rapidly with the pressure.

The "pre-test" system of White must be considered as an ingenious application of our knowledge concerning the compressibility of the sand. Due to the similarity of the stress-strain diagrams of various kinds of sand the ratio between the total compression and the "rebound" can be considered as an indicator of the degree of safety of the pile, and due to this fact it seems that one can entirely

overcome the necessity of pre-testing the pile for any load which is appreciably in excess of the one the pile has finally to carry.

Unfortunately the application of the pre-test system seems to be confined to those cases where the subsoil consists of sand. Such beds of sand can be considered as being in equilibrium before the load is applied, and the coefficient of internal friction is variable within rather narrow limits only (with a few exceptions). On the other hand, beds of clay are rarely in a state of final equilibrium, due to the low rate of drainage and evaporation, which complicates the conditions considerably. A short time ago I had an opportunity to investigate closely a case where loading tests, piledriving tests and borings gave fully satisfactory results, while the building as a whole suffered unequal settlments of more than 1 ft. in the course of a few years. An analysis of the samples furnished by the borings showed that the percentage of sand (grains >0.06 mm.) contained in the muddy substrata ranged between the limits of 42 and 73 per cent, while with the naked eye no difference could be detected between the various samples and the subsoil was considered as being of the same character throughout.

This and similar experiences naturally call our attention to the composition of the various kinds of soil. The results of a wet mechanical analysis of a sample, supplemented by the physical characteristics of the components (limits of plastic state and of liquid state according to Atterberg) are the least one must require. No such data were communicated for instance in the article "Plastic-Fill Method Cuts Costs of Earth Dike," *Engineering News-Record*, Aug. 5, 1920, p. 268. It is therefore impossible to identify a soil suitable for the successful application of the interesting method, and one has to take the risk of failure over and over again.

How misleading the general statements concerning the character of the soil may be is clearly demonstrated by the case of the hydraulic-fill dam. Scores of engineers have claimed that the cores of these dams consist of clay, until Allen Hazen showed that for the sake of stability the effective size of grains of the core-material ought to be not smaller than about 0.01 mm. As the term "clay" must be confined to particles smaller than 0.002 mm., the clay content of such cores is almost negligible. Everybody who has experimented with clay solutions knows that a sediment rich in clay remains forever in a semi-liquid state, unless it is compacted either by evaporation, capillary pressure, or an external pressure (surcharge) amounting to several atmospheres. The history of our knowledge concerning hydraulic-fill dams shows how many years of actual experience and of expensive failures it takes before the fundamental facts emerge from the jungle of non-essentials. It seems therefore to be more economical to search for these elecentary facts in the laboratory first, instead of discovering afterward how easily these facts can be demonstrated on experimental scale.

DR. CHARLES TERZAGHI.

Constantinople, June 1.

Drafting Room Kinks

Sir—In connection with the note on "Drafting Room Kinks," *Engineering News-Record*, June 23, p. 1077, for many years I have been using almost the same method as Mr. McCurdy has. Instead of attaching the paper with mucilage, I found that strips of tracing cloth about 1 in. wide pasted about one-half on the drawing paper and one-half on the surface paper, worked admirably. They not only hold the paper in place but can very easily be stripped off and be used time after time.

WILLIAM H. WAITE,
The Browning Co.

New York City, June 27.

Protection of River Banks with Spur Dikes

Sir — Experience on the Rio Grande River may throw some light on the letter of inquiry of Enrique Ramirez, *Engineering News-Record*, May 26, 1921, p. 909, in regard to the protection of river banks with spur dikes. There is no way to calculate or predetermine, graphically or analytically, the distances between proposed dikes. Moreover, it is assumed that current is deflected at right angles to the axis of the spur dike.

The only way to determine the proper location of each dike is to build one at a time, starting at the upstream end of the threatened territory. After a dike is completed,

CURRENT DEFLECTED BY DIKE

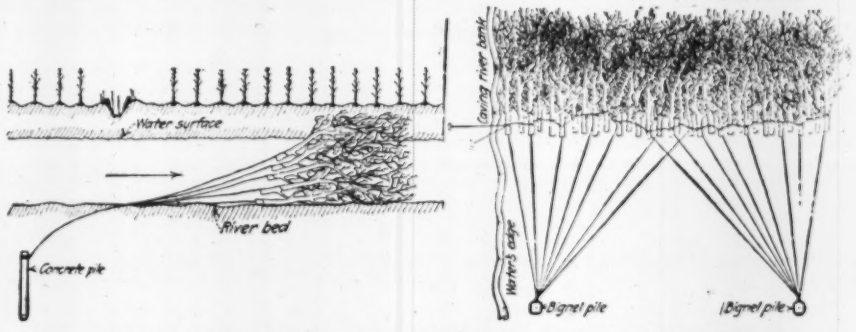
the change in current shows very plainly to what extent the bank below is protected, indicating the exact spot where the next jetty should be located. The proper position of a dike is with its nose pointing downstream, since (1) the current of a river flows in a series of reversed curves and (2) it is the outer edge of the curve where the centrifugal force of the stream cuts or endangers banks.

With a dike placed at right angles, as in Fig. 1, current is deflected toward the opposite bank with a comparatively short radius. The reverse curve strikes back at the threatened bank in a shorter interval and with greater centrifugal force than current flowing in a curve of longer radius. The current of the stream is deflected in the curve of longer radius by a dike pointing downstream as in Fig. 2. The dike in Fig. 1 acts also as an abrupt impediment to the current, which is converted into whirlpools, while the dike in Fig. 2 gives an easy transition to the current. Pointing the dikes downstream also reduces the number, because the flatter the reverse curve, the greater is the distance between dikes.

PHILIP FLITMAN,
Superintendent of Construction, U. S. Indian Irrigation Service.

Cochiti, N. M., June 11.

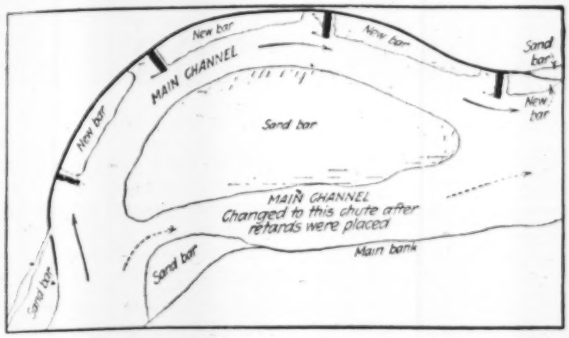
Sir—Letters to the Editor have appeared in *Engineering News-Record*, May 26, p. 909, and June 16, 1921, p. 1047,



DIKE OF UNTRIMMED TREES ANCHORED BY CONCRETE PILES

with regard to spur dike river bank protection, and it is thought that a method recently developed on the Missouri River would be of interest.

It has long been recognized that almost any permeable dike which would permit the passage of a sufficient portion of the current to prevent formation of eddies would efficiently protect a river bank by the formation of bars as indicated in Mr. Chester's letter published June 16. This result is accomplished in the so-called "retard system" by building the dikes of untrimmed trees. These trees are made up in sections on a barge fastened together with cable and then fastened by anchor cables to a concrete pile which is sunk in the river bed to a point where its head is from 10 to 15 ft. below the bottom of the river. The depth to which this pile can be sunk places it beyond any chance



CHANNEL DIVERTED BY PLACING BRUSH RETARDS

of erosion and the surplus strength in the cables has been found ample to prevent destruction of the dike. It soon buries itself in the sand which it causes the river to deposit. In one case at Rulo, Neb., a fill of 9 ft. was secured in one week, so it can be seen that the dike is rapidly buried.

This method of protection is much cheaper than mattress revetment and fully as cheap and much more stable than pile dikes. Several successful pieces of work have been done for the C. B. & Q. Railroad and one for the Illinois Central, for the protection of revetment.

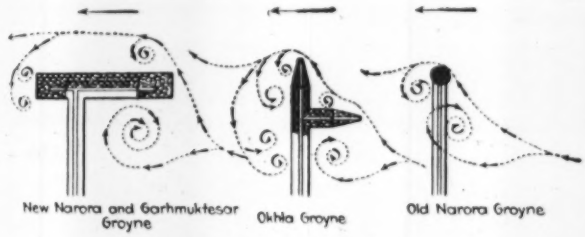
WILLIAM G. ATWOOD,
Manager St. Louis District, Woods Brothers Construction Co.

St. Louis,
June 20.

Sir—With reference to the current discussion on the protection of river banks with spur dikes, the Indian practice of building spur dikes, or groynes, as they are commonly called in India, may be interesting.

The Indian rivers have a tendency to shift their courses and raise their beds by the deposit of silt. On account of these conditions severe inundations often occur and sweep out over all low lying ground. The destruction of villages and crops are a result along such unprotected rivers.

The object of training works is to protect cities, farms and engineering works. The methods ordinarily employed to influence river current direction or action are:

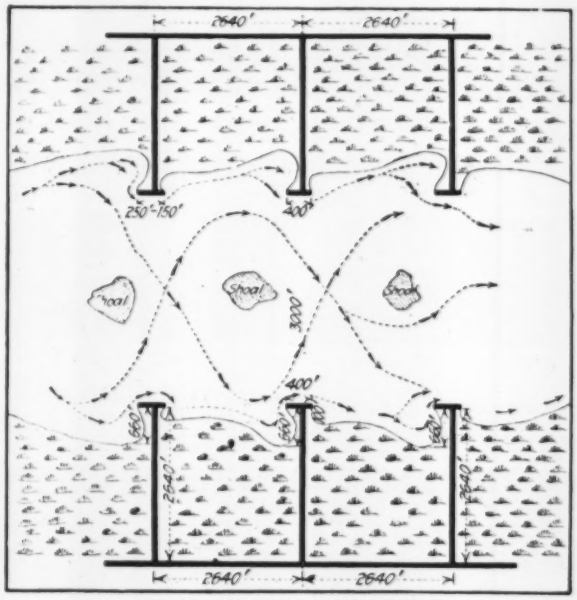


FORMS OF GROYNE HEADS

(1) By levees or "bunds" (which in the vernacular means a closing or shutting off).
(2) By cuts changing the position of the stream.
(3) Subsiding aprons, causing or limiting scour.
(4) Permeable spurs, partially obstructing or directing the stream.
(5) Impermeable spurs, or groynes, influencing or directing the stream.

The function of the groyne or spur is not of itself directly to oppose the current, but to hold up a great mass of dead water and thus protect the banks. A very slow motion of the dead water is an advantage, because it may lead to the formation of a bed of hard clay on the bank of the river above the groyne, on account of a slow deposit of silt. The engineer should realize that if the original material of the bed and banks remain unchanged, and the river gradient is not in any part artificially absorbed, the channel will regain its original length, in some way or other. The training works should be designed to preserve the natural regimen of the river, and furthermore they should be permanent if

The following extracts are from notes made by P. Denehy, an authority on Indian river training works:



ACTION OF HOODS ON GROYNE

(1) The result of a series of groynes at half mile intervals is to straighten the river out and to cause silt to deposit in between them, but there is always a loop cut out above and below each groyne, the greatest depth of the loop observed in 20 years is 660 ft., or exactly ¼ of the distance between the groynes.

(2) The whole length of the groyne should if possible be in a straight line.

(3) The groyne heads should be parallel to the river, and at right angles to their embankments, the whole groyne being again at right angles to the marginal "bund," or other work, which has to be protected.

(4) The faces of the groyne heads should be perfectly free from any irregularities or projections, such as trees, cribs or small spurs, all such projections create swirls and eddies which tend to undermine the groyne heads.

(5) All diversions of rivers and spill channels should be made inside or at the land side of the groyne head, for if they are put into the river they offer obstructions and tend to injure the structure.

(6) If the head of the groyne has to be built where there is deep scour, do not alter the position of the groyne to avoid expense of filling up the hole, as a great deal depends upon the alignment of the groyne; and do not fill up the hole with solid material, which is a useless expense, and in fact is injurious to the structure as it would cause irregularities in the currents. The best thing to do is to fill up with sand to low water level and build the groyne head on top of the made sand platform. Should the velocity at the site of the head be too great to admit of sand filling, it may be necessary to make a coffer-dam, with brushwood or other perishable material, and if rubble or broken bricks has to be resorted to, care should be taken that no solid material projects outside the groyne head.

(7) The proper method of closing or diverting a channel which may happen to lie inside the alignment of a proposed groyne head is to first raise an embankment at both sides of the channel, so as to prevent the water from spilling over the banks when the channel is being closed; having thus secured both the flanks from erosion, collect a sufficient quantity of material close at hand to close the channel in as short a time as possible. Have sufficient boats to form a gangway right across the channel. Material should be placed on both flanks. A crowd of men should be put on to place the material which should be laid right across the full width of the channel in 2 ft. layers. If this is done there will be little or no scour, as the bed gets gradually the results are to be permanent.

paved.

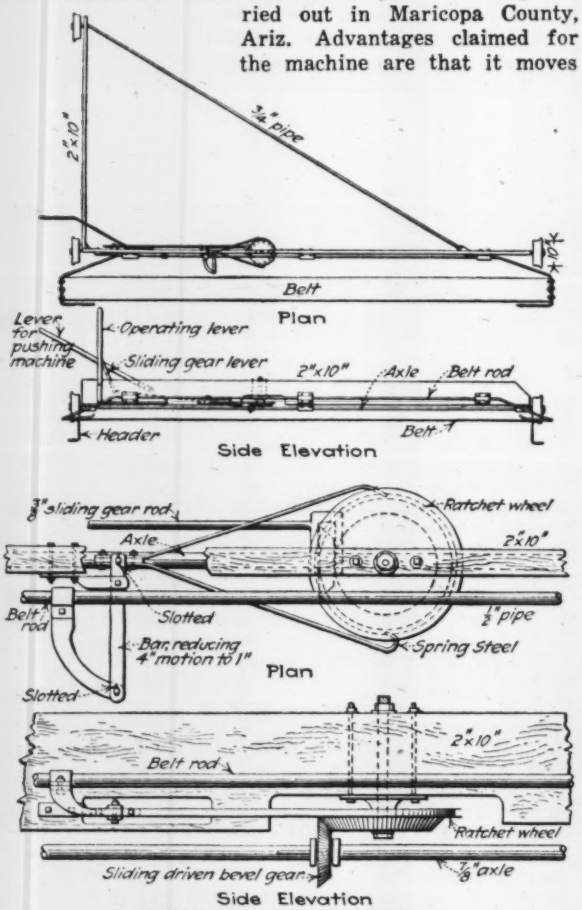
H. L. THACKWELL,
Hydraulic Engineer.

Denver, July 3.

HINTS FOR THE CONTRACTOR

Hand Belting Machine for Pavement Has Propelling Device

A HAND-BELTING machine with a device for automatically moving it forward as its belt is operated back and forth across the pavement, has been developed on the extensive road construction job now being carried out in Maricopa County, Ariz. Advantages claimed for the machine are that it moves



DETAIL OF PROPELLING DEVICE

DETAILS OF THE DRIVING MECHANISM

forward at a uniform rate and hence the uniformity of the belting does not depend on the proper advance of the machine by the operator.

The framework of the machine is made up either of timber or pipe and is arranged to be carried by three wheels operating on the header boards. The belt is operated in the usual way by a hand lever. The length of the handle and its mounting are such that a 14-in. throw of the end of the handle (considered most efficient for the average operator) gives the belt a 4-in. movement in a transverse direction and moves the machine forward 1 in. The forward motion is obtained by means of a ratchet wheel operated by a lever from the belt rod, the ratchet wheel being arranged to drive a bevel gear attached to the axle of the machine.

When it is desired to disconnect the driving mechanism, a lever draws the driving bevel gear away from its mate. When desired the machine can carry a bridge enabling workmen to cross the freshly poured pavement.

Concrete Blocks Hold Swelling Bottom in Brick Sewer

IN AN 11½-ft. sewer tunnel in Detroit clay, occasional slight swelling of the invert cut when it is trimmed for the brickwork, has been successfully checked by substituting 8 x 12 x 12-in. precast concrete blocks for the bottom course of brick. The area of the blocks enables the swelling bottom to be quickly covered and their weight holds the earth down until the ring of blocks can be keyed and the joints cemented. This cementing is done by sifting dry cement into the joints and pouring water on them. The day cement takes up this water and moisture from the bottom and quickly forms a joint strong enough to resist slight swelling. Contractors employing this method claim that a stock of precast blocks for the occasional emergency of holding a swelling bottom is an insurance against delays which sewer masons can well afford.

Protecting Hose From Vehicles

BY C. W. GEIGER
San Francisco, Cal.

A DEVICE for protecting hose where it crosses a roadway is shown in the accompanying illustration. It consists of two parallel pieces of metal held together at the desired angle by five metal straps riveted in place.

MEANS OF PROTECTING HOSE ACROSS ROADWAY

By using fairly heavy metal, cross pieces on the bottom are unnecessary, hence the device can be laid down over a hose without interrupting the flow of water wherever it is desired to provide a vehicle crossing.

NEWS OF THE WEEK

New York, July 14, 1921

No Action on Highway Bills

No action was taken last week on the highway legislation before Congress. Senator Townsend, chairman of the committee on postoffices and post roads, was unable to be in Washington during the week; his absence precluded any action on either the Townsend bill or the bill passed by the House. Both bills now are in the hands of the Senate committee.

Colorado River Lengthened by Congressional Action

The Senate on July 8 passed the bill already approved by the House changing the name of the Grand River in Colorado and Utah to the Colorado River. This insures the change, as there is no doubt as to the President's signing the measure. This gives the river one name from its source to its mouth. Sixty per cent of the water in the Colorado River has its source in the state of Colorado, it was declared during the discussion of the bill.

New Proviso Inserted in Permits for Dam Construction

So as not establish a precedent which might interfere with the future use of water for power purposes, the Senate committee on commerce has worked out a proviso which is to be made a part of future authorizations for the construction of dams for non-power purposes. The proviso reads as follows:

"That the consent hereby given shall terminate and be at an end from and after 30 days' notice from the Federal Power Commission or other authorized agency of the United States to said company or its successors that desirable water-power development will be interfered with by the existence of said dam; and any grantee or licensee of the United States proposing to develop a power project at or near said dam shall have authority to remove, submerge, or utilize said dam under such conditions as said commission or other agency may determine, but such conditions shall not include compensation for the removal, submergence, or utilization of said dam if the water level to be maintained in said power project is higher than the level of the crest of said dam."

The proviso was made a part of the bill giving authority to the Trumbull Steel Co. to construct a dam across the Mahoning River near Warren, Ohio. With that proviso, no further objection was offered to the measure, and it was passed. The House accepted the amendment. A similar bill authorizing the construction of a dam across the Wabash River at Huntington, Indiana, also has been approved by both Houses.

Fire Destroys 30th St. Bridge in Pittsburgh

A fire of unknown origin on July 8 wrecked a large part of the 30th St. bridge, which crossed the Allegheny River at Herrs Island. The bridge was a steel truss structure with wooden floor, built in 1888 for a private company and acquired by the public (Allegheny County) in 1911. The northerly part of the bridge, from Herrs Island to the north bank, was built at a later date by the Pennsylvania R. R., but is maintained by the city.

The fire was discovered shortly before 1 p.m., the first warning being a small cloud of smoke noticed by an automobile driver crossing the bridge. Before the occupants of the automobile could return with a fire extinguisher the "entire structure burst into flames," as local reports describe it, and less than three-quarters of an hour later two spans collapsed, within a few minutes of each other. The longer of the two was about 200 ft. in length. Some coal barges below the bridge were ignited by flying brands and were destroyed.

Wires and pipes supported under the bridge hampered the fire-fighting efforts; however, reports that a gas main which broke when the first span fell increased the intensity of the fire, are not supported by facts now at hand.

National Office of Roads in France Is Proposed

A proposal has been brought before the French Chamber to constitute a National Office of Roads, since the roads in France have been allowed to fall into an exceedingly bad state. This authority, if constituted, will be an entirely autonomous body and not in any way connected with the Ministry of Public Works.

Plan Again for Building Code for Pennsylvania

A new movement has been started at Harrisburg for the preparation of a state-wide building code to be submitted to the Pennsylvania legislature. Such a code was prepared by a broadly representative committee for submission to the last session of the legislature, but it failed of passage under pressure of legislative work in the closing days of the session.

Damages for Broken Water Main

Damages to the amount of $3,000 for property flooded by a broken water main have been awarded against the city of Montreal, Que., by the Superior Court of that city.

Los Angeles Accepts Hog Feeding Method of Garbage Disposal

A majority of the Los Angeles city council on June 30 voted to enter into a ten-year contract for the sale of the city's garbage to G. W. Whitman, a contractor who proposes to feed the garbage to hogs. The bid was 96c. per ton and the plan, according to press reports, is to locate the hog farm near Montebello. Under the terms of the contract the city will deliver the garbage to a loading station probably near the present plant of the Pacific Reduction Co. whence the contractor would be required to remove it to a point at least 3 mi. outside the city limits.

The vote of the council was made over the protest of its president, and vigorous opposition in carrying out the proposed plan is expected from interested citizens. In opposing the measure, the president of the council said: "By approving this bid we are terminating our contract with the Pacific Reduction Co., and in case these contractors are unable to secure a permit from the county, or are unable for any other reason to handle the garbage, the city will be in a terrible situation."

The county health department stated that the successful bidder had not applied for a permit to operate a hog farm in the county and if adjacent property owners protested, it was doubtful whether such a permit could be secured.

An Alternative Proposal

The city council and board of public works have had under advisement a proposal by C. D. Crouch, builder of the plant operated by the Pacific Reduction Co., which is now handling the city's garbage, that the city should lease the reduction plant for a year with an option to purchase. This would afford a loading station for use in carrying out the hog-feeding plan and would retain for the city a means for disposal in case the hog-feeding plan should fail or be stopped by legal procedure.

Mr. Crouch has also submitted a plan whereby he proposes that the city screen the sewage in a screening plant (built near the present garbage reduction works) and add to the present garbage plant equipment for drying the screenings so they could be used for fertilizer. A considerable portion of the garbage, he said, could be put through the same process and disposed of in the same way. Experiments made in drying screenings show that they can be converted into a dry practically odorless product, he stated, which could be sold in sacks for a good price.

An average of about 250 tons of garbage is now collected daily and sold for 51 cents per ton to the Pacific Reduction Co. Of late with the declining value of grease, the chief product of the reduction works, the plant has been offered for sale to the city for $450,000. It has been in operation for about six years.

Position of Power Administrator in California Abolished

The position of power administrator has been abolished and the power administration department of the California State Railroad Commission was discontinued June 30. The office was created in June, 1918, as a war emergency measure and the power administrator was given authority to regulate the power resources of the state so as to pool all available electrical energy. In discontinuing this department the commission recommended that the work of co-ordination of power uses might well be continued with advantage by the various power companies.

American Engineers Receive Foreign Honors

With the presentation of the John Fritz medal to Eugene Schneider, head of the famous Creusot Works, in Paris, July 8, by a mission of American Engineers, came cable advices from London to the American Society of Mechanical Engineers announcing that more foreign honors had been conferred upon Americans distinguished in the engineering profession. The cable message, addressed to Secretary Calvin W. Rice, stated that Ambrose Swasey, of Cleveland, sponsor of the Engineering Foundation and past-president of the American Society of Mechanical Engineers, had been elected to honorary membership in the British Institution of Mechanical Engineers, in the British Institution of Mining and Metallurgy and in the British Institution of Mining Engineers.

Charles F. Rand of New York, it was stated, had been elected an honorary member of the Institution of Mining and Metallurgy, and of the Institution of Mining Engineers. Mr. Rand, who is chairman of the executive board of the Engineering Foundation, has just been made an honorary member of the British Iron and Steel Institute.

Other elections announced by cable were those of Col. Arthur S. Dwight of New York and William Kelly of Vulcan, Mich. to honorary membership in the Institution of Mining Engineers. This group of honors is believed to be without precedent in engineering and was described by Mr. Rice, who has been active in promoting closer relations between American and British engineers as an important step in bringing about world solidarity in the engineering profession. A movement, it was said, has been started in the direction of federating the engineering societies of the British Empire according to the plan of the Federated American Engineering Societies.

Boston Invites Bids for Garbage and Refuse Disposal

Bids for the disposal of garbage and refuse, either singly or combined, are wanted by the City of Boston until Sept. 6. The contract will be for ten years from July 1, 1922. The city will deliver the garbage at three wharves and the refuse either at two wharves or at a dump or dumps provided by the contractor at a distance of not over three-fourth mile from one of the wharves. Garbage is defined as including both food and its containers and refuse as nearly everything else ever covered by that term except sewage, but including street sweepings and material removed from catch basins.

The city not only holds itself free from liability for garbage or refuse withheld by producers but also reserves to itself the right to dispose of part or all of the refuse, without holding the contractor or itself in anyway liable therefor. The bids are to be on a lump-sum yearly basis. The city reserves the right to deliver any or all of the garbage to the contractor in sealed receptacles, provided by it, in which case the contractor must take the receptacles to the plant unsealed, empty them, clean them and return them to the city. The price for this extra service, in case of disagreement between the city and the contractor, is to be determined by arbitration.

Contractors Bid on Jersey Shafts of Vehicle Tunnel

With the award of contract 2 for the construction of the ventilating shafts at the Jersey end of the Hudson River vehicular tunnel, bids for which were received by the New York-New Jersey tunnel commissions July 12, work will be in progress on both sides of the river, and it is expected that before Sept. 1 the two commissions will be in a position to call for bids for constructing the twin tubes of cast iron underneath the river. Work on the Jersey end of the project has been delayed by a controversy involving the widening streets in Jersey City and the adjustment of certain real estate matters with the Erie R.R. These differences have been composed and the way is now open for the award of the tunnel contracts as soon as the shaft work on the Jersey side has progressed far enough.

While certain property rights involved in the tunnel construction are still under adjustment, it is understood that the engineering plans and specifications for the twin tubes are now completed, so that a call for bids will find everything in readiness. Experiments are still under way to determine upon final details of ventilating the tunnels, but the cross-section and type of construction by the shield method have been definitely determined and as far as the engineering department is concerned the work is ready to be placed under contract.

Aug. 3 is the date which has been fixed for the ceremony of breaking ground for the Jersey end of the tubes.

Prouty's Death Will Not Halt Valuation Work

Charles A. Prouty, director of valuation of the Interstate Commerce Commission, died at his home in Newport, Vermont, July 8. The death of Mr. Prouty, according to a statement by the commission, will not interfere with nor have any effect upon its valuation work for the reason that for months during his illness, Division 1 and the associate director have had and will continue to have entire control of the valuation work.

Start New Water Power Development in Vermont

The New England Power Co. has started construction work on a 4,500-kw. hydro-electric power plant at Searsburg, Vt. This plant is located on the Deerfield River about 4 mi. from Wilmington. The company has in operation six plants below Searsburg, on the Deerfield, which utilize a total head of about 525 ft. The Searsburg plant will have a gross head of about 235 ft., or a net operating head of 215 ft. The company also has in operation a storage reservoir of 2,500,000,000 cu.ft. capacity about 5 mi. above the Searsburg plant so that the Searsburg development will increase the value of its storage water about 45 per cent.

The development includes a low earth dam of about 50,000 cu.yd. across the bed of the river with a concrete spillway located on ledge to one side of the present river bed. From the dam the water will be carried in an 8-ft. diameter wood stave pipe about 18,000 ft. along the west side of the river to a surge tank. From the surge tank the water will be carried to the power house in a 6½-ft. diameter steel penstock. The power house will be a concrete substructure with steel and brick superstructure and will contain one 4,500-kw. unit. Aside from the switchboard the principal electrical apparatus will be located outdoors, including the 2,300/66,000-volt transformers.

The power from this plant will be handled over new transmission lines extending to plant No. 5 of the company near Hoosac Tunnel, Mass., and to the Vernon plant below Brattleboro. In all, there is about thirty-six miles of this transmission line which will be constructed as 66,000-volt single-circuit line.

The development is being designed and the work carried out by the Power Construction Co., Worcester, Mass.

Banker Optimistic On Irrigation

Irrigation development in the West is awaiting a turn in financial conditions to reach enormous proportions, says J. W. Harrison, chairman, Anglo and London-Paris National Bank, San Francisco, in the June *Bulletin* of the Investment Bankers Association. Projects proposed in California alone will require financing to the extent of $400,000,000 and other western states are alive to their own requirements.

Recommend Tube and Bridge for San Francisco Bay

A preliminary report by J. Vipond Davies and Ralph Modjeski on the proposed San Francisco Bay crossing was announced on July 7. The two engineers were retained by the San Francisco Motor Car Dealers' Association to report on the general question of improved means of crossing the bay. The leading features of the plan which they recommend are as follows:

Starting on the San Francisco side somewhere between Mission Rock and Potrero Point, a tunnel extends out under the bay about 3,000 ft., connecting with 12,000 ft. of bridge followed by concrete pile causeway, followed in turn by permanent fill extending to a point near the south end of the proposed naval base site in Alameda. The bridge section of the crossing is composed of 300-ft. cantilever spans.

As outlined the project would cost $40,000,000, including preliminary surveys, engineering, administration cost, and interest during construction. Two railroad tracks and a 20-ft. roadway are provided in the tunnel section, while on the bridge the roadway is widened to 40 ft. The tunnel would consist of three parallel tubes, one for each track and one for the roadway. The engineers estimate that the structure can be completed in three years and eight months from the time it is decided to start.

In its general lines this project is similar to that developed by J. G. Little and C. H. Snyder, as described in *Engineering News-Record* of July 7, p. 17.

More Rail Valuations Completed

The Interstate Commerce Commission has completed its tentative valuation of the property of the Pacific & Idaho Northern Ry., as of June 30, 1916. The investment in road and equipment, including land, on the date of valuation is stated in the books of the carrier to be $5,534,163.83, the report shows. Of this amount, $4,600,438.56 represents the par value of securities issued in payment for the road and equipment. The cost of reproduction new and the cost of reproduction less depreciation of all common-carrier property, other than land, wholly owned and used by the carrier are held to be $2,302,826 and $1,932,897, respectively. The carrier owns and uses for its purposes land having a present value of $125,716.68. The commission values the property of the road at $2,100,176.

A tentative valuation also has been made of the property of the Intermountain Ry. Co., an Idaho corporation. The value of the property of that carrier was found to be $991,127. The investment in road and equipment, including land, is stated in the books of the carrier to be $915,298.05. The cost of reproduction new and the cost of reproduction less depreciation of all common carrier property, other than land owned and used by the carrier, are reported to be $1,006,073 and $951,396, respectively.

Another valuation report covers the Fourche River Valley & Indian Territory Ry. Co., of Arkansas. The value of the property owned and used by that carrier was set at $250,000.

Diamond Drilling Starts on Columbia River Dam Site

Contract for diamond drill exploration of a dam site on the Columbia River near the head of Grand Coulee in the state of Washington was let in June and drilling was to start the first week in July. The work is being done by the state department of conservation and development, which is conducting the Columbia Basin survey. Drilling at this point is being undertaken on the recommendation of the federal reviewing board of engineers which passed on the Columbia Basin irrigation project. A resumé of this project appeared in *Engineering News-Record*, Nov. 11, 1920, p. 944. In case granite bedrock is found to be more than 150 ft. below the boulders and glacial deposit the site will be abandoned. If sound bedrock is found nearer the surface the entire site is to be drilled and mapped.

This work is not being done in accordance with the report of the Columbia Basin Survey Commission, which was adverse to the construction of a dam at this point on the ground that it would require a pumping plant to work against a head of 615 ft. and would require 990,000 hp.

Six bids on the diamond drilling were received. The contract was awarded to the International Diamond Drill Contracting Co., whose proposal was that the state should pay all costs plus a rental on equipment supplied by the company of $19 per day of two eight-hour shifts with option permitting the state at the end of any month to designate that the succeeding work should be paid for at cost plus from $1 to $1.50 per ft. drilled, the rate depending upon the progress in the preceding months.

Move Bridge to New Piers

The Des Moines River Bridge of the Atchison, Topeka & Santa Fe R.R. at Dumas, Mo., is to have new piers built 42 ft. east of the present piers, the six 150-ft. deck truss spans being then shifted 42 ft. longitudinally. One of the spans will be shortened by two panels. The old piers were built of a local sandstone which has deteriorated to such an extent as to render reconstruction necessary, but the abutments are in good condition. It is planned to build the new piers long enough for double track, the single track spans being reinforced at some later time for the E-65 loading and a second track being added. Plans for the work are being prepared and it is expected that contracts will be let this summer. As this bridge is over a navigable stream the work has been authorized by an act of Congress approved in June.

John F. Wallace

John F. Wallace, consulting engineer of New York City, whose death in Washington, D. C., on July 3 was announced in last week's issue of this journal, was most widely known as the chief engineer in 1904 of the Panama Canal, although his professional experience covered a number of other important engineering works, particularly in the Mississippi Valley, where his achievements in the railway field first won for him the recognition which led eventually to his appointment as chief engineer and general manager of the Illinois Central R.R. He was recipient in 1900 of the highest honor within the power of his professional associates to bestow—the presidency of the American Society of Civil Engineers—having served the society as treasurer in 1913-14 and as vice-president in 1897-98. One of his most recent professional engagements was as chairman of the Chicago Railway Terminal Commission.

JOHN F. WALLACE

Mr. Wallace was born in Fall River, Mass., in 1852 and after graduation in 1871 from Monmouth College in Illinois, he became a U. S. assistant engineer on Mississippi River improvements, his early work being at the Rock Island rapids, above Hampton, Ill., where he designed and built special machinery for excavating a steamboat channel through the St. Louis chain of rocks.

In 1879 he engaged in railway work as chief engineer of the Burlington, Monmouth & Illinois River R.R., becoming superintendent when the road was completed, and master of trains after it was consolidated with the Iowa Central. At the same time he served as engineer on various improvements under construction. In 1886, as assistant engineer for the Union Pacific Ry., he was in charge of surveys in the Rocky Mountains and the next year was appointed bridge engineer of the Santa Fe., under Octave Chanute, consulting engineer of the company. In that capacity, he had charge of the building of the Missouri River bridge at Sibley, Mo.

The Illinois Central R.R. retained Mr. Wallace in 1891 and his time was devoted largely to the transportation problems in connection with the World's Fair and to the general improvement of the railway company's Chicago terminals. In 1892 he was appointed chief engineer of the Illinois Central and in that capacity directed the track elevation and lake-front improvements in Chicago, extensive terminal work at New Orleans, East St. Louis, Louisville and Memphis. In 1898 he became assistant second vice-president, in 1901 assistant general manager and, one year later, general manager.

Mr. Wallace was chosen chief engineer of the Isthmian Canal Commission in 1904. Leaving the work at Panama in 1905 he was appointed consulting engineer on the Chicago terminal of the Chicago & Northwestern Ry., and in 1906 was elected president of Westinghouse, Church, Kerr & Co., New York, serving with this company for eleven years during which time he became chairman of the board. He remained in that capacity until the recent consolidation of that company with other interests. He maintained an office in New York City as consultant to large corporations and also served as chairman of the Chicago Railway Terminal Commission.

Mr. Wallace was elected president of the American Society of Civil Engineers in 1900. He was also a past-president of the Western Society of Engineers and of the American Railway Engineering Association.

At the time of his death, Mr. Wallace was in Washington attending hearings of the Senate committee on interstate commerce.

Permit Granted for Large Power Project on Coosa River

On June 27 the Federal Power Commission, acting under the federal water power act, issued a license to the Alabama Power Co. for a 120,000-hp. water power development on the Coosa River in Alabama, at a location known as Duncan's Riffle. Work has already started on the project which will comprise a concrete, gravity type dam 1,200 ft. long, to develop a head of 68 ft. The initial installation will be two 24,000-hp. vertical units with turbines of single runner type, directly connected to the generators and with provision for the installation of three additional units as the demand from the market may require. The transmission line will connect with the existing line of the company, about 12 miles distant.

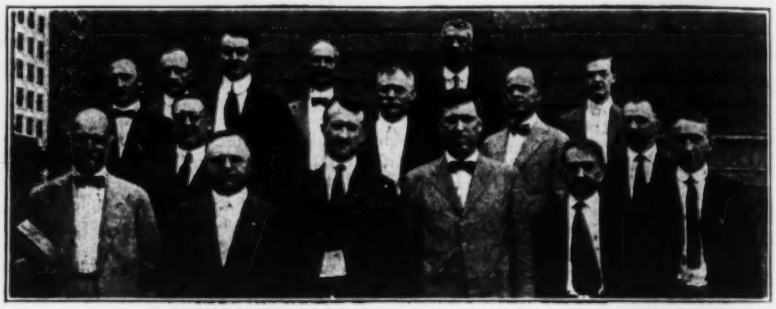
An announcement by the Federal Power Commission states that the company plans to introduce two noteworthy departures from previous design of similar plants. One of these is the location of the units on the upstream side of the dam, each in a separate inclosure and upon its own concrete foundation. The other improvement is in the draft tubes which will reduce loss of head during periods of high water by discharging upward at the toe of the dam. O. G. Thurlo, chief engineer of the Alabama Power Co., has designed the spillway and the tailwater channel so as to keep the standing wave downstream from the draft tube outlets at all stages of discharge.

The reservoir created by the dam will have an area of about 6,000 acres. The license issued to the company provides that whenever a definite project is adopted for the improvement of this section of the river by the federal government the company will install the necessary locks and channels for navigation.

A. A. E. Board Names Committee to Confer with F. A. E. S.

Business transacted by the board of directors of the American Association of Engineers at the quarterly meeting held June 24 and 25 included the following: (1) The country was divided into 12 districts for the purpose of representation on the board. (2) Provision was made for continuing the Washington office. (3) Kenneth Talbot was appointed head of a committee to draft a plan for financing an enlarged employment service. (4) An invitation is to be issued to all engineers to submit questions on ethics for reference to the practice committee; after a sufficient number have been passed on they will be published. (5) No general membership drive is to be undertaken, but a student membership campaign was authorized to be conducted in the fall months. (6) The committee on services and fees, headed by Langdon Pearce, was authorized to hold a national conference of practicing engineers. (7) H. O. Garman, president; A. N. Johnson, first vice president and C. E. Drayer, secretary, were appointed as the committee to meet with a similar committee from the executive board of the American Engineering Council of the Federated American Engineering Societies, to study relations and co-operation, (8) Dean G. M. Butler, Prof. Frederic Bass and Dean A. N. Johnson, were named as the committee authorized by the Buffalo convention to classify engineering schools.

Fourteen of the fifteen directors were present at the meeting.



NEW OFFICERS AND BOARD OF DIRECTORS OF AMERICAN ASSOCIATION OF ENGINEERS

Top row, left to right—Directors: Charles A. Finley, Pittsburgh; L. E. Ayres, Ann Arbor; W. C. Bolin, Chicago; G. M. Butler, Tucson; E. F. Ayres, Boise; B. A. Bertenshaw, Cincinnati.

Middle row—Directors: W. L. Benham, Kansas City; Morris Bien, Washington; Frederic Bass, Minneapolis; W. E. Vogelback (proxy for Garrison Babcock, Everett, Wash.), Chicago.

Lower row—W. B. McKeen, director, Omaha; Henry W. Clausen, treasurer, Chicago; C. E. Drayer, secretary, Chicago; H.O. Garman, president, Indianapolis; A. N. Johnson, first vice-president, College Park, Md.; A. S. Morris, second vice-president, Chicago.

Port Development Plans Wanted

An international competition for port development plans has been called by the harbor board of the city of Trelleborg, Sweden. The plans are required by Nov. 1, 1921. Three prizes are offered, of 20,000, 15,000, and 8,000 kroner, and it is provided that plans not awarded a prize may be purchased by the board for 2,000 kroner.

Permanent Engineering Board for Delaware River Bridge

On June 30 the Delaware River Bridge joint commission adopted a plan for the organization of a permanent engineering force for the construction of the Philadelphia-Camden bridge, and reappointed the board of engineers which prepared the report submitted June 9 and adopted by the commission two weeks later. The organization of the board has been modified, however. Ralph Modjeski is chairman and chief engineer at a salary of $2,500 a month, to include traveling expenses. George S. Webster and Lawrence A. Ball, the other two members of the board, will receive $1,000 a month each.

In accordance with the report of the commission's engineering committee, the chief engineer and chairman is to be in complete charge of design and erection of the structure, is to organize a staff subject to the commission's approval, prepare designs and specifications, assist the commission in letting contracts, direct the work in office and in field, have power to dismiss subordinates and fill vacancies, call meetings of the board of engineers and consult with the members of the board on all phases of the work, make monthly reports to the commission, call on experts for temporary service, when advisable, approve and sign requisitions, and prepare and sign estimates. The board is to advise the commission on all matters pertaining to the project, hold weekly meetings and approve in writing contract drawings and specifications. Differences arising in the board shall be reported to the commission in writing. A complete record of the proceedings of the board is to be kept for reference of the commission, and monthly reports shall be made. The plan outlined by the committee also provides for an inspection department, an assistant to the chairman and chief engineer, an engineer of designs for the approaches, an engineer of design for the main bridge, and 3 engineers of construction.

New Dry-Feed Chemical Device

A dry-feed chemical apparatus—the Booth dry feeder—adapted to the application of chemicals in water treatment and for other purposes has recently been placed on the market by Wallace & Tiernan. A conical-shaped feed hopper discharges onto a table rotated by a ½-hp. motor at 1½ to 8½ r.p.m. The chemical is scraped off the table into a flushing hopper or, in the case of water treatment, directly into the water supply. In addition to speed regulation of the rotating table the rate of feed may be changed by an adjustable collar around the feed spout. Within the conical hopper is a shaft carrying two agitator arms and a chain to prevent packing or arching of the chemical.

PERSONAL NOTES

JOHN HORRIDGE has been appointed supervising engineer in the division of street cleaning, department of public works, Philadelphia, Pa.

GEORGE W. GREEN has been appointed municipal engineer of the Canal Zone by Governor Jay J. Morrow to fill the vacancy caused by the resignation of D. E. Wright.

O. FROSETH, formerly assistant engineer with the Miami Conservancy District, Dayton, Ohio, is now in the office of the chief engineer of the Illinois Central R.R., Chicago, Ill.

HERMAN H. SMITH has been recommended by the chief engineer of the Board of Estimate and Apportionment, New York City, for the position of deputy chief engineer.

CHARLES F. RAND, chairman of the executive board of Engineering Foundation and one of the leaders of post-war research in American industry, has been elected an honorary member of the Iron and Steel Institute of Great Britain. Mr. Rand is a member of the engineer mission which has gone to France to bestow the John Fritz medal on Eugene Schneider, head of the Creusot works.

H. F. ANDERSON, resident engineer of Mecosta County, Mich., has been appointed road engineer of Mecosta County.

FRANK F. SINKS, at one time a member of the firm of Condron & Sinks of Chicago and in recent years connected with various engineering works in the Northwest, has opened an office in Seattle for the practice of industrial and structural engineering.

PROF. ARTHUR M. GREENE of Rensselaer Polytechnic Institute has accepted the call of the trustees of Princeton University to become dean of the engineering school and professor of mechanical engineering. He will take up his new duties in September, 1922. Prof. Greene is a graduate of the University of Pennsylvania and also holds an honorary degree of D.Sc. conferred in 1916. He has taught mechanical engineering at Drexel Institute, at the Universities of Pennsylvania and Missouri and at Rensselaer, and has been prominent in the American Society of Mechanical Engineers as manager and vice-president and at present is chairman of the society's research committee.

E. E. SOURS, formerly road engineer of Mecosta County, Mich., has been appointed road engineer for Allegan County, Mich.

HERBERT S. CROCKER, formerly acting secretary of the American Society of Civil Engineers, has re-opened his office in Denver, Col., to specialize in design and superintendence of construction of bridges, buildings, foundations and public utilities. Attention will also be given to investigations, reports, valuations, and special engineering problems.

VIRGIL W. SAMMS, formerly city engineer of Pocatello, Idaho, and later connected with the construction department of the Oregon Short Line R.R., has been appointed surveyor general for the state of Idaho.

EDWARD MOSHER, formerly township engineer, Cranford, N. J., has been appointed town engineer, Westfield, N. J., in charge of the construction and maintenance of roads and sewers and the operation of the sewage disposal works.

ELWIN QUINNEY, formerly county highway superintendent, Beadle County, S. D., is now resident engineer with the South Dakota state highway commission in charge of the construction of state and federal aid roads in Codington and Deuel counties with headquarters at Watertown.

F. E. ROSS, recently with the Missouri highway department, has been appointed city engineer of Jefferson City, Mo.

W. O. HINKLEY has obtained a leave of absence from the Union Pacific R.R. as instrumentman on maintenance-of-way and is at present engineer with the Stanley Consolidated Mines of Idaho Springs, Col., engaged in underground surveying and the design of small structures.

CHARLES M. BINFORD has opened an office in Beckley, W. Va., as civil and mining engineer to specialize in examinations and reports of coal lands and properties, the design and construction of coal plants, the improvement of existing plants to increase their capacity, town planning and building, suburban development and supervision of construction.

R. W. DOWNIE, recently with the Canadian Inspection and Testing Co., Ltd., has been appointed tester of building materials for the Welland Ship Canal with laboratories and office at Merritton, Ont.

HERSCHEL C. SMITH, formerly deputy state highway engineer of Oklahoma, has been appointed professor of highway engineering and highway transport at the University of Michigan from which institution he graduated in 1913. Last October he was elected Roy D. Chapin fellow in highway transport at the university.

BERNARD J. FALLON, assistant general manager and formerly engineer maintenance-of-way of the Chicago elevated railway system, has been appointed general manager.

OBITUARY

JAMES OWEN, for about 45 years engineer of Essex County, N. J., and for 17 years town engineer of Montclair, N. J., died in Bayhead, N. J., July 5. He was born in London, England, in 1845 and was educated in private schools and at King's College, London. He was apprenticed at the age of 15 to G. K. Radford, civil engineer. In 1864 Mr. Radford came to the United States and became chief engineer on the construction of the Indiana Southern Ry.; about a year later Mr. Owen joined Mr. Radford as assistant. In 1867 Mr. Owen was appointed assistant engineer to the Brooklyn Park Board then engaged in laying out Prospect Park. The following year he was appointed engineer of the Essex County (N. J.) public road board and later in 1868 he was named county engineer of Essex County, which position he held with slight interruptions until 1913, when he retired to engage in consulting practice. During his official connection with Essex County and while serving Montclair and other communities as engineer, Mr. Owen played a considerable part in both the pioneer and the later work which gave New Jersey its system of improved highways. He also did a large amount of other municipal work, having been connected with the construction and early operation of the plant of the Montclair Water Co., and with the sewerage and sewage disposal works.

PROF. FRANCIS B. CROCKER, electrical engineer, founder in 1886 with C. G. Curtis of the C. & C. Electric Motor Co. and, two years later with Dr. S. S. Wheeler, of the Crocker-Wheeler Electric Co., died in New York City, July 9. He was born in New York City in 1861 and was graduated from the school of mines, Columbia University, in 1882 and received the degree of Ph.D. in 1894. In 1886 he was head of the department of electrical engineering of Columbia University and about eleven years later he became the chairman of the first standardization committee of the American Institute of Electrical Engineers. He served the A. I. E. E. as president and manager and vice-president. He was considered one of the best informed men in the industry on electrical patents. His most important contribution to the electrical industry was the development of standards of design for a wide variety of electrical equipment.

Business Side of Construction

Facts and Events that Affect Cost and Volume

Lumber Production Costs

The committee on statistics of the American Wholesale Lumber Association advises that the manufacturing costs among the southern lumber manufacturers for January was $27.58 per thousand ft.b.m. In February this figure had been reduced to $24.22 and in March $22.43. The interesting situation in some mills was found that no expense was entailed in shipping and selling departments, while the maximum expense of any mill reporting was $3.43 per thousand ft.b.m. The average of all the companies, including those that showed no expense for shipping and selling, in January reported an average cost of $1.95, and in February $1.79 per thousand ft.b.m.

Net Operating Income of Railroads $37,246,000 in May

The railroads of the United States had a net operating income in May of $37,246,000, which was approximately $7,997,000 more than it was in April, according to reports just filed by the carriers with the Interstate Commerce Commission. This is the largest amount earned by the railroads since last November when their net operating income was $54,343,793. Comparisons show that eighty railroads—twenty-eight in the eastern, nineteen in the southern and thirty-three in the western districts—had operating deficits in May while in April the total was 91.

On the basis of the tentative valuation fixed by the Interstate Commerce Commission for rate making purposes under the Transportation Act, the amount earned in May would be at the annual rate of return of 2.41 per cent compared with 2.2 per cent the previous month. The reports show, however, that the carriers fell short $55,490,000 or 59.8 per cent of earning the amount contemplated by the Act.

The tabulations are based on reports from 201 Class One railroads representing a total mileage of 235,450 miles.

Highway Work in California Totals $6,000,000

How important a part state highway work has played in solving the problem of unemployment in California is indicated by contracts let for state highways since the beginning of the year. In all thirty-five new contracts calling for an expenditure of approximately $6,000,000 have been let by the California Highway Commission during the first six months of 1921.

This work was distributed all over California and in addition to other work under way constitutes a large factor in relieving unemployment conditions in California. Bids on other sections are being asked and a large highway program is well under way.

Building in Manhattan Borough

According to the report of the bureau of buildings for the Borough of Manhattan, New York City, for the first six months of 1921 plans were filed for the construction of 421 new buildings estimated to cost in excess of $53,000,000, as compared with plans filed for 434 buildings to cost $67,000,000 for the first six months of 1920. The number of dwellings planned for 1921 is six times that for which plans were filed during 1920, though the average cost of the 1921 dwelling is about one-half of the 1920 cost.

Proposed new tenement houses have increased in number from fifteen to forty-two, and the total estimated cost from $7,925,000 to $9,660,000. The average number of apartments in a Manhattan tenement house is about forty. A fact to be noted in connection with house construction is that, while only 15 per cent of the residence buildings proposed in the first half of 1920 were actually started in the same period, over 75 per cent of the proposed residences for the first half of 1920 have been started in that period.

Business buildings, not including those that are devoted entirely to office purposes, increased in number about 67 per cent. The estimated cost of 1921 building of this class is about two and a half times what it was for the same period of 1920. Office buildings, on the other hand, show a decided falling off, the decrease in number being 25 per cent and about 45 per cent in estimated cost. There was a decrease in estimated cost of nearly 20 per cent in the number of proposed stables and garages, and about 45 per cent in the estimated cost of alterations.

Brooklyn Building Breaks Record

The total value of new buildings and alterations, miscellaneous structures and plumbing permits for which plans were filed during the first six months of 1921 in Brooklyn, N. Y., was $71,131,073. The total for the first half of 1920 was $50,670,901. The total of new building plans filed at Brooklyn, including dwellings, apartment houses, theatres, offices, factories and stores, was $63,808,055. Plans were filed in Queensboro during the first half of 1921 for new buildings to cost $28,438,521 as compared with structures to cost $22,510,246 in the corresponding six months of 1920. The total of new buildings for Bronx during the first six months of 1921 was 1,192 to cost $26,404,450 as compared with 630 buildings for the first half of 1920, costing $11,750,180.

In the entire city of New York, plans were filed during the first six months of 1921 calling for an expenditure in excess of $184,000,000 a gain for the first six months of 1921 over the first half of 1920 of $30,000,000.

Steel Seeks a Basic Level

The announcement by the Bethlehem Steel Co. of a general decrease in prices effective July 5 was followed by a similar announcement by the United States Steel Corporation, effective July 6. Thus, for the second time in three months the Steel Corporation has met the market created by the independents. The dealers are doing their part to make steel an attractive purchase as early as possible. Responding to the mill decrease, they have lowered warehouse prices by 20c. per 100 lb. on beams, channels, angles and tees, the new quotation being $3.03. It is the opinion of the trade that there will be no further price changes for the next two months at least. Both Bethlehem and the Steel Corporation report improvement in smaller orders, but it is too soon to predict whether the present scale will stimluate large construction. Some believe that structural shapes must go to $1.75 before there will be a satisfactory response from the large buyers. The average price just before the war was $1.50, with a minimum of $1.08 in the latter part of 1914. One thing is certain, steel in moving towards the old normal figure is leading the other construction materials.

New York Cement Prices Unstable

For some weeks the price of cement in New York has been $2.80 delivered, exclusive of bags, but at present keen competition among the dealers has created a market ranging from $2.60 to $2.80. In fact, a quotation as low as $2.50 net has been heard. The average market appears to be $2.60 net or $3 per barrel including bags. When it is considered that handling charges amount to 23.8c. per barrel and that cement costs the dealer $2.80 (with bags) alongside dock, it is apparent that if the price is to go much lower, the manufacturer will have to take the matter in hand. It appears, however, that the price will not be reduced until the fall.

Freight Rate Reductions

Since June, 1920, the Western Trunk Line Committee, an association of railway officials which has been hearing applications for reduction in freight rates, has considered 1,200 subjects, over 90 per cent of which were reductions and nearly all affected rates increased last year. The reductions concerned particularly crushed rock, gravel, building materials, as well as coal, lumber, and other commodities.

The reductions ranged from 5 to 70 per cent. Among the applications on which reductions were approved were twenty-four for brick, cement and lime, and fifteen on iron and steel rails, structural iron, and ferro-manganese.

Texas Highway Work Underway Totals $26,955,348

There are now under construction in the state of Texas 192 state and Federal-aid projects, involving the building of 2,301 miles of highway for which the total contract cost is $26,955,348. Of this amount, $9,260,986 is Federal-aid money which has actually been granted. Of the 2,301 miles under construction 83.7 miles are being paved with concrete, 421 miles with bituminous types, 1,265 miles with gravel. Although the remaining mileage is surfaced with a cheaper class of material, all drainage structures will be permanent. There are seventeen projects totaling 144 miles not yet under contract but upon which plans have been approved and which are estimated to cost in excess of $3,500,000. Of other work proposed, project statements have been approved for sixty-five projects, 653 miles long and estimated to cost approximately $10,000,000, for the construction of which $2,500,000 of Federal aid and more than $1,000,000 of state aid have already been allotted.

There are now a total of 414 projects under the supervision of the state highway department either being maintained, constructed or proposed, involving more than 4,000 miles, for which the total estimated expenditure is approximately $49,000,000.

St. Louis County to Let Road Work Worth $2,000,000

On July 22 the county commissioners of St. Louis County, Minn., propose to let contracts for the construction and improvement of certain highways which will involve the expenditure of $2,000,000. The work will include 56 miles of grading work and 28 miles of paving. The contracts for $1,500,000, awarded during 1920, will be practically completed this year. The new work to be let on July 22 will be scheduled for completion by the fall of 1922.

Number Surplus Cars Decreases

The demand for freight cars continues to increase according to reports received from the rail carriers of the country by the car service division of the American Railway Association. These show that on June 30, there were 373,791 surplus freight cars or a decrease of 4,059 compared with the total on June 23.

The total number of box cars including ventilated, automobile and furniture cars, in excess of current freight requirements was 146,298 which was a decrease within a week of 6,335. A decrease of 1,445 coal cars was also reported, the total on June 30 being 162,537 compared with 163,982 on June 23. Surplus stock cars numbered 18,170 compared with 20,029 one week before or a reduction of 1,859. These reductions, however, were in part counteracted by an increase of more than 6,200 in the number of surplus cars of miscellaneous classes.

Forest Service to Establish New Experiment Station

The U. S. Forest Service has announced that a new experiment station will be established this month at Asheville, N. C., to be known as the Appalachian station. Steady depletion of the southern Appalachian timber supply is responsible for the location of this station. Its chief object will be to obtain information needed for determining the best methods of handling forest lands in the southern mountains.

For many years the United States has depended for a large part of its hardwood timber on North Carolina, Virginia, West Virginia, Kentucky, Tennessee, Alabama, Georgia and South Carolina. The crest of hardwood production in this region, with a cut of approximately 4,000,000 000 ft. was reached in 1909. By 1918 the production had fallen nearly 60 per cent.

The country as a whole will, in the future, have to depend on the mountain slopes of the Southern Appalachians for a very large percentage of its high-grade hardwood, the bulk of which is now in the lower Mississippi valley.

The general timber situation is exceedingly serious official foresters say. Three-fifths of the original timber stand has been destroyed or utilized and a considerable percentage of the remaining two-fifths is made up of inferior second growth. One half of the timber left is in the three Pacific Coast States, Washington, Oregon and California.

Concern Builds Steel Houses

Making small houses almost entirely of steel has been undertaken on a large scale by the International Housing Corporation, a New York concern. Most of the main framing in these houses is of lumber, but the siding, roofing, eaves and gutters are of interlocking steel strips, first galvanized and then painted. The interior finish is of insulated wall and ceiling boards. Roof sheets are bolted to the eaves and ridges on all four sides and firmly fastened with hangers and tie rods from the ridges to cross T-bars so that the roof and four outer walls form a rigid unit.

The houses are of several sizes, all of one story. The largest now being built is 20 ft. by 36 ft., outside dimensions.

It is understood that the company plans a large development in the construction of these steel houses on Long Island where it recently acquired a large amount of property.

Because of the insulation of the wall and ceiling board it is said that these steel houses are practically sound proof.

Production of Southern Pine Falls

Production of lumber for week ending July 1 reported by the Southern Pine Association was 25.6 per cent below normal. Shipments were 17.9 per cent below normal production and orders 20.8 per cent. Orders were 6.5 per cent above production and 3.6 per cent below shipments for the week.

National Bodies Begin Joint Clay-Products Research

The chairmen of the respective research committees of the American Face Brick Association, the Common Brick Manufacturers Association, the Hollow Building Tile Association and the National Paving Brick Manufacturers Association, together with the secretaries of these associations, representatives of the federal government, universities and the American Ceramic Society, met in Chicago on June 16 to perfect an organization through which the co-operation of the association may be made effective in clay-products research.

A plan of research proposed by the technical committee and accepted by the executive committee in behalf of the four associations, contemplates the investigation of commercial kilns, represented by the up-draft and the down-draft kiln, the continuous kiln of the straight tunnel type, the compartment continuous kiln and the tunnel car kiln, as the first consideration. The second part of the research work will deal with the study of the water smoking and de-hydration process by the Bureau of Standards; the study of steam absorption throughout all the burning stages by the ceramic department of the University of Illinois; the study of oxidation and burning stages by the Bureau of Mines, and experiments and study of combustion and transmission of heat in a semi-commercial kiln by the Bureau of Mines at Columbus.

Funds with which to carry on the research work will be furnished by the joint research committee and by the various federal bureaus making investigations. Out of the $10,000 fund of the joint research committee recommendation was made by the technical committee and approved by the executive committee that $7,500 be placed to the credit of the Bureau of Mines and $2,500 to the credit of the Bureau of Standards. Each of these bureaus will then with its own funds augment the joint committee funds and it is expected that three times that much money will be available during the year.

A. V. Bleininger, of the Homer Laughlin Pottery Company, is the chairman of the technical committee. The other members are R. H. Bates, U. S. Bureau of Standards, Washington; R. C. Purdy, American Ceramic Society, Columbus; R. T. Stull, United States Bureau of Mines, Columbus, and E. W. Washburn, University of Illinois.

Great Sale of Wooden Ships by U. S. Government

Bids are called by the U. S. Shipping Board for the sale of a large fleet of wooden ships built for the board during the war. No less than 285 ships are to be disposed of; they are of eleven different types, ranging from 2,500 to 2,900 deadweight tons. Over half of the vessels (180) are of the Ferris

type. These are 286 ft. long, 42 ft. 2 in. in beam, 26 ft. deep, and are equipped with triple-expansion engines of 1,400 hp. and two standard water-tube boilers. With a bunker capacity of 477 tons, these vessels have a steaming radius of 3,954 miles at 8 knots. The details of the other ships differ slightly.

Bids are to be opened July 30 at 10:30 a.m. in the office of the Shipping Board, Washington, D. C. The call states that bids will be received from all nations in the world, and that the board will recognize accepted bids from foreign countries as providing for the transfer of flag privilege. A sale commission of 5 per cent will be paid brokers making accepted bids.

New York Employers Propose Wage Cut

The Building Trades Employers Association of New York City has asked that the Building Trades Council meet the employers to discuss the proposition of reducing the general scale of wages now being paid building trades mechanics. The proposed meeting is the culmination of a proposal made more than a week ago by the various building trade associations to their respective unions that the unions consent to a $1 a day decrease. The unions asserted that the question of wages was in the hands of the central council, to which body the matter has been referred by the constituent unions.

Contract Value of Past Week Is Third Highest of Year

Contracts let during the past week, as reported in *Engineering News-Record*, had a total value of $32,265,002, more than $12,000,000 in excess of the contract value for the corresponding week of 1920—$19,776,015. The figure of the past week is well above the weekly average for 1921, and is the third highest figure yet recorded for the year. That is remarkable in that, usually, after the spring peak has been reached, the total value of contracts let falls off. The past week's report carries news of the letting of the Bethlehem bridge contract — $2,568,000 — and a $1,602,892 government dredging project.

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of July 7, the next, on August 4.

Steel Products:	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Structural shapes, 100 lb.	—$3.03	$4.00	$4.50	—$2.93	—$3.31	$4.65	—$4.25	$4.60	$5.00
Structural rivets, 100 lb.	—4.40	5.25	5.75	4.88	—5.20	—6.00	—6.00	5.50	8.50
Reinforcing bars, ¾ in. and larger, 100 lb.	—2.93	3.25	3.75	3 00	3.53½	—3.77½	2.35	4.00	4.25
Steel pipe, black, 3½ to 6 in. lap discount	—51%	50.65-5%	45%	58½%	51.9-5%	—36%	49.80	47½%	5%
Cast-iron pipe, 6 in. and over, ton	—49.10	59.22	65 00	—49.10	—57.80	70.00	80.00	65.00	75.00
Concreting Material:									
Cement without bags, bbl.	—2.66@2.80(del.)	—2.50	2.80	2.17	2.46	3.10	3.09	3.10	4 28
Gravel, ¾ in., cu.yd.	2.50	2.35	3.00	2.25	2.00	2.50	2.25	1.50	1.50
Sand, cu.yd.	1.25	1.40	2.50	2.25	1.00	1.10	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd.	2.15	2.25	2.80	2.50	2.25	3.50	2.25	3.50	2.10
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	47.00	40.00	35.00	55.00	36.00	47.00	27.00	28.50+120 00	
Lime, finishing, hydrated, ton	21.00	—20.50	25.00	20.00	29.00	32.00	25.40	24.00	30 00
Lime common, lump, 200 lb. bbl.	3.30	—1.45	2.75	1.65	1.50	3.10	2.25	2.75	15.00
Common brick, delivered, 1,000	18.40	+11.50	12.50	12.00	17.00	14.00	18.00	16.00	18.00
Hollow building tile, 4x12x12, block	Not used	.14	.13	—.09475	.092	.09	.12½	.11	—.15
Hollow partition tile 4x12x12, block	.1232	.15	.13	—.07410	.092	.10	.14½	.12	.....
Linseed oil, raw, 5 bbl. lots, gal.	.76	—.78	.98	—.84	— 88	.95	.96	.79	.84
Common Labor:									
Common labor, union, hour	.75@.80	.35	.....	1.00	50	.50@.63½	.81½	.75	.....
Common labor, non-union, hour	.....	.25	.35@.45	.45	.50	37½@.50	.50@.55	.50	—.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given: 45-5% means a discount of 45 and 5 per cent, 45@50 means a range of 45 to 50 per cent. Charge of 15c. per 100 lb. for cutting reinforced steel into 2-ft. lengths or over. **New York** quotations are delivered except tiles, which are "on trucks." Sand, gravel and crushed stone are quoted alongside dock. **Chicago** quotes hydrated lime in 50-lb. paper bags. **Minneapolis** quotes on fir instead of pine. Brick and hollow tile delivered. Gravel, sand and crushed stone quote at pit. Common labor not organized. **Denver** quotes cement "on tracks"; gravel and sand at pit, stone on cars, lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil delivered. **Atlanta** quotes sand, stone and gravel per ton instead of cu.yd. **Dallas** quotes lime by the 180-lb. bbl. Steel and crushed stone are quoted f.o.b. cars, other materials delivered. **San Francisco** quotes on Heath tile, 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Lumber prices are delivered "at ship tackle in San Francisco ex mill." **Seattle** quotes on Douglas fir instead of pine; and on lime in paper bags. **Montreal** quotes sand stone, gravel and lump lime per ton. Cement, lime and tile are delivered; sand, gravel and stone, on siding; brick f.o.b. plant; steel and pipe at warehouse. No organized common labor in Montreal.

Changes Since Last Week

The readjustment by the Bethlehem Steel Co. and the U. S. Steel Corporation, effective July 5 and 6, respectively, is already reflected in lower prices at warehouses throughout the country. New York and Minneapolis dealers report a decrease of 20c. per hundred pounds. Shapes are down 10c. in San Francisco, while rivets can be bought for $6 as against the recent quotation of $6.40. Reinforcing bars that cost $5 during the 1920 peak, can now be purchased delivered in New York for $2.93. Bars are down 55c. in Denver. Steel pipe is down in New York and Denver, while cast-iron pipe is $5 lower in Chicago and Minneapolis, $5.90 in San Francisco.

The cement situation in New York is explained elsewhere in this section. Atlanta reports a 10c. decrease on cement, and a 50c. drop on hydrated lime, and 5c. per bbl. on lump lime.

The wholesale price of Southern pine in New York is $42. The cost to contractors, on lighters or cars, is about $5 additional. Hollow building tile is cheaper in Chicago and Montreal.

Common labor is obtainable in Montreal at 30c. per hour. In the Chicago controversy the arbitrator's decision is still deferred. The carpenters have finally agreed to accept this decision when rendered, pending a referendum. Minneapolis reports that while building operations are more active in that city than at this time a year ago, construction is slowing up. Home building is in heavier proportion than other classes of construction, but there is a marked feeling that heating and plumbing materials and hardware will drop in price.